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CONTRACT 169

REPORT NO. 5

UPPER ATMOSPHERE WINDS FROM

GUN LAUNCHED VERTICAL PROBES

(Barbados, 17-25 February 1966)

SPACE INSTRUMENTS RESEARCH, INC.



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# DISCLAIMER NOTICE

BRL CONTRACT 169 REPORT 5

# UPPER ATMOSPHERE WINDS FROM GUN LAUNCHED VERTICAL PROBES

(Barbados February 17-25 1966)

Prepared for

U. S. Army
Ballistic Research Laboratories
Aberdeen Proving Ground, Maryland

Contract No. DA-01-009-AMC-169(X)



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# INTRODUCTION

A continuing study of upper atmospheric winds over the lower West Indies has been made possible by the firing of high altitude ballistic probes from a sixteen-inch gun located on the Island of Barbados. These firings are being carried out by the U. S. Army Ballistics Research Laboratories, Aberdeen Proving Ground, Maryland, under the direction of Dr. Charles H. Murphy, and by the Space Research Institute of McGill University, Canada, under the direction of Dr. G.V. Bull.

Atmospheric winds are studied by releasing chemical trails from the gun-fired probes during the upper portion of their trajectories. To date, the primary chemical which has been released is trimethyl aluminum (TMA). TMA produces a chemiluminescent glow in regions of the atmosphere above 85 kilometers, thus allowing the trails to be photographed while being distorted by upper atmosphere winds. The photographs are then reduced to provide wind information by Space Instruments Research, Inc. (SIR), using computer techniques.

The purpose of this report is to summarize results of these studies for the period from February 15 through February 25, 1966. Previous results for winds over Barbados, West Indies, and Yuma, Arizona, are covered in Technical Reports Nos. 1, 2, 3, and 4.

## DATA ACQUISITION

The chemical trails are formed almost vertically over the Island of Barbados (longitude 59.4°W, latitude 13.0°N) and extend from an altitude of 85 kilometers through apogee. In some firings, TMA is also released on the down leg of the trajectory. To the unaided eye, the chemical release first appears as a straight white trail resembling a jet contrail. Within a minute or so, the trail is distorted into strainge shapes by the upper atmospheric winds (see Fig. 1) and fades from view within approximately fifteen minutes after initial release.

Space Instruments Research has established eight photographic triangulation stations on the islands of Barbados, St. Vincent, Grenada, and Tobago, with two sites per island. These latter islands are located to the west and south of Barbados at distances of 190 to 290 kilometers (see Fig. 2). While only one site on each of two islands is required for data reduction purposes, the eight sites have been found necessary because of cloud conditions in the area.

Equipment at each site, built by SIR, consists of a camera unit containing two seven-inch focal length cameras mounted on a concrete pedestal, and an electronic control. Cameras are automatically pulsed to take exposures of 3, 6, and 12 seconds duration every 30 seconds.

Since commercial power is either unreliable or unavailable at many site locations, SIR has developed a battery operated 115-volt power supply for the control equipment. The power supply is tuning-fork controlled and provides 60 cycle power with an accuracy of 0.005%

for the camera programmer so that pictures can be taken simultaneously at each site. A data block containing 24 tiny lights, mounted in each camera unit, records time, firing number, and site information in the corner of each frame of film.

A short wave radio net connecting all sites and the launch control center has been installed by SIR to enable the launch control officer on Barbados to be informed of weather conditions on the islands and to synchronize picture-taking operations with the firing of the gun. Most sites are operated by local personnel who have been trained by SIR.

During a typical night's operation, the gun is fired at one to two-hour intervals, from sunset to sunrise. Photographs are taken by all sites during the time that the trail is visible. The film is returned to Atlanta for processing and data reduction.

## DATA REDUCTION

Several computer programs have been developed which make it possible to calculate upper atmosphere winds from measurements made directly on the photographs of the luminous trails.

Since the method used is basically three-dimensional triangulation using spherical trigonometry, it is necessary to know precisely the direction each camera was pointed during a given firing. The direction is determined by first taking accurate measurements of the locations of several star images on the film, and then computing the azimuth and elevation of the optical axis of the camera by means of a computer program. This computer program makes use of the celestial coordinates of some 6,000 stars which have been stored on magnetic tape.

Wind speeds and directions are then determined from the location of the trail in space at a succession of known times. The location is found, using either a point location program or a trail location program, or both, and depends on the physical shape of the chemical release cloud.

<u>Point location method</u>. If the chemical release exhibits discrete points (resulting either from turbulence or from the nature of the release mechanism) and these points can be identified on films from two or more sites, the point location program can be used to calculate the position of each point in longitude, latitude, and altitude above sea level.

These calculations mare made from data taken at successive times. A wind program is then used to calculate both vertical and horizontal winds from the motion of these points as a function of time.

Trail location method. Most of the chemical releases produce a smooth trail having few, if any, identifiable points. In such cases, film coordinates of a large number of incremental points along the film image of the trail are fed into the computer from data from two or more sites. The trail location program attempts to triangulate each point from one site with many points from another site, finally choosing points from both sites whose optical paths from camera into space form the closest spatial intersection. After doing many hundreds of such calculations, the computer is able to construct coordinates for a mathematical curve in the shape of the trail in space. Then, as with the point location program, winds can be determined from the motion of the curve with time. Here, however, it must be assumed that vertical winds are essentially zero. This assumption is borne out by previous studies which have shown vertical winds in this altitude region to be of the order of a few meters per second compared to horizontal winds ranging up to 150 meters per second.

Corrections for variables such as atmospheric refraction, rotation of camera about optical axis, and camera focal length, are incorporated into the programs to maintain high accuracy. Focal length and camera rotation are, in fact, calculated from measurements of the positions of star images on the films.

## INTERPRETATION OF DATA

In the remainder of this report, horizontal wind velocities are presented in tabular form and in plots of wind speed, direction, and components.

Winds were calculated at altitude intervals of one kilometer. Points on the various plots show the actual computed result, as listed in the table preceding the plot. A curve has been fitted to each set of points to aid in detecting wind patterns and to indicate reliability of the plotted results. Each curve has been drawn with a knowledge of intermediate results leading to the wind calculations and of the consistency of the winds as calculated between each of the five or more time intervals used. In cases where point-to-point curve fitting was not thought to reflect actual variations in wind speed, direction, or components, a more appropriate smooth curve has been drawn. Otherwise, the curves are fitted directly to the data points. Results of certain portions of the trails are at times less accurate than others due to the spatial orientation of those trail segments relative to the available photographic stations. Less accurate data also can result from photographs obscured by haze and clouds and from trails of short duration.

Wind speed plot. This plot shows the speed of the wind in meters per second as a function of height in kilometers above sea level.

Wind direction plot. The wind vector is considered to point in the direction toward which the wind is moving. The direction plot shows the direction of this vector in degrees clockwise from north as seen from above. Thus, a wind direction toward the east would be 90 degrees.

Wind components plot. While plots of wind direction and speed do completely describe the wind vector, it has been found helpful in studying wind patterns to present the north-south and east-west velocity components of the vector. In the north-south plot, north is positive; south is negative. In the east-west plot, east is positive, west negative. Components are plotted in meters per second versus height in kilometers.

The wind direction and components described above are referenced to true north. In addition, components have been calculated relative to magnetic north for comparison with other ionospheric phenomena. These components are not plotted but are listed in the tabulations preceding each set of plots.

Fig. 1

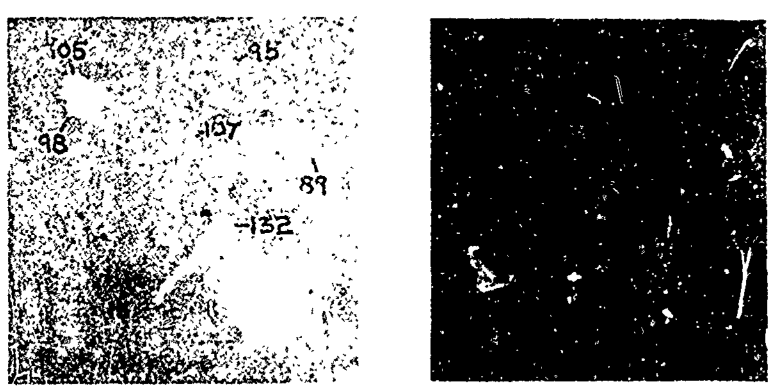
Photographs of firing St. Kitts

Photographs taken 167 seconds after firing:


Barbados St. Vincent Tobago

These pictures were taken from three islands just as the vehicle reached apogee. Note that the winds have already distorted the trail. Numoers indicate altitude in Kilometers.

Photographs taken 250 seconds after firing:

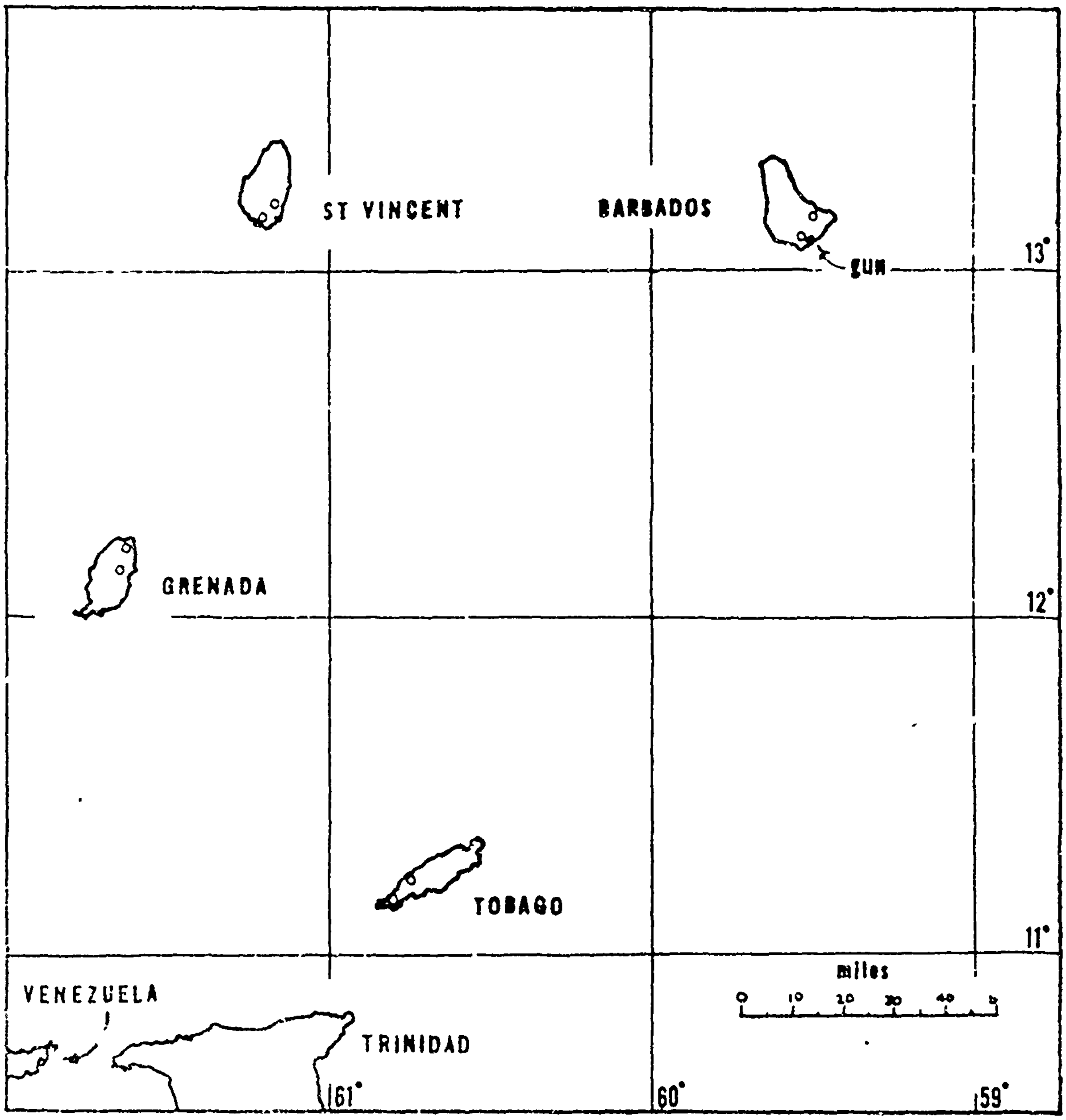



Barbados Tobago

This set of pictures was taken at completion of the downtrail. The uptrail shows the continued effect of the winds, while the downtrail is new and only slightly distorted. Stars can be seen in the background of these pictures. The positions of these stars are used to determine the exact direction each camera was aimed.

Fig. 2

Location of S.I.R. photographic stations
H.A.R.P.-Barbados




Two stations are located on each of the four islands, as shown. While only one station on each of any two islands is sufficient for determination of winds by triangulation, several stations were found necessary because of prevalent cloud conditions in the area. Accuracy of the data reduction is also increased by use of films from more than two islands.

## SYNOPSIS OF RESULTS

The following comments may be helpful in interpreting the data contained in this report. Only those shots with unusual characteristics are discussed.

INAUGUA

Downtrail results above 111 kilometers were significantly different from uptrail results. Two curves are shown in this area. Below this region it was not clear whether or not there were actual differences between the up and down results, so only one curve was drawn.

ST. KITTS

The region 95 through 98 kilometers gave poor results. The points are not thought to be accurate, thus a smooth curve was drawn through them.

MONTSERRAT

Very poor photographic data due to bad weather made analysis of this trail difficult. Only a small portion of the trail length was useable. Winds shown are generally less accurate than other trails.

ST. THOMAS

This trail had a very unusual characteristic. Above 110 kilometers, up through apogee, and into the downtrail, the release split into two trails. These two trails showed different apogees and different winds.

Photographs of this release seem to indicate that the two trails rejoined in the down leg, but for two reasons we believe this is not the case. First, triangulation results show different positions for the two trails near where they appear to join. Second, three other trails whose data has not yet been reduced show very similar double trails, and on these the downtrails do not rejoin. In fact, the lower trails seem to join the "reentry bags" -- indicating that the second trail may be formed by the vaporization of previously frozen TMA crystals as they follow their own trajectory. We believe the lower trail of this shot twisted in front of the upper, causing them to appear to join.

Data from the up leg of this second trail was too poor to give useful results. Thus results for one uptrail and two downtrails are shown. The lower (revaporization) trail is called trail "A". Figure three shows a ground projection of these trails.

Fig. 3

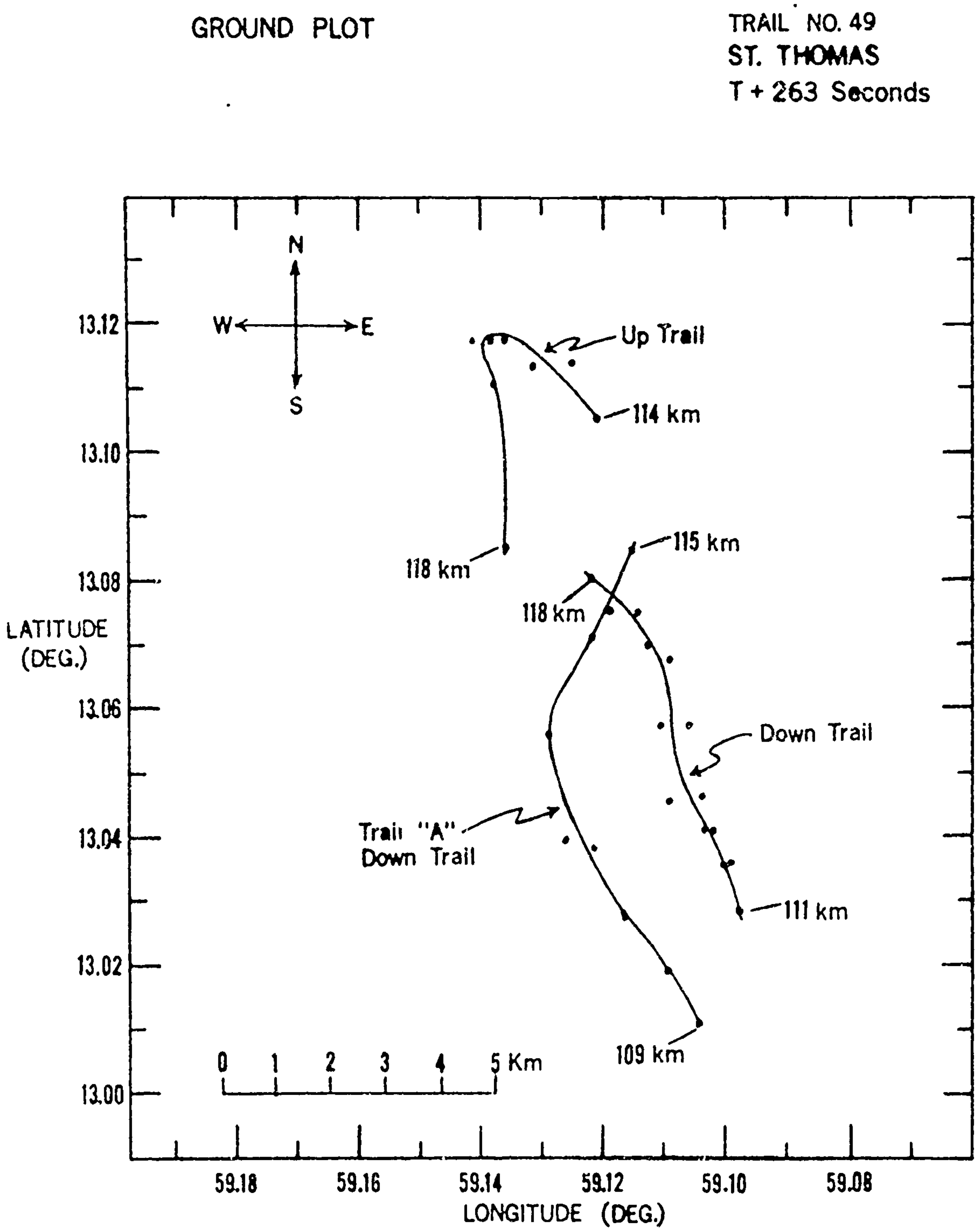

GROUND PLOT
TRAIL NO. 49
ST. THOMAS
T + 263 Seconds
N
W
E
S
13.12
13.10
13.08
13.06
13.04
13.02
13.00
LATITUDE (DEG.)
Up Trail
114 km
118 km
115 km
118 km
Down Trail
Trail "A" Down Trail
111 km
109 km
0 1 2 3 4 5 Km
59.18
59.16
59.14
59.12
59.10
59.08
LONGITUDE (DEG.)

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TABLE OF TRAIL INFORMATION

| TRAIL NO. | NAME | DATE | TIME (A.S.T.) | ALTITUDES (KM.) |
|---|---|---|---|---|
| B43 | Inagua | 17 February, 1966 | 21:03:00 | 92 - 123 |
| B44 | St. Kitts | 23 February, 1966 | 20:46:00 | 87 - 131 |
| B45 | St. Lucia | 23 February, 1966 | 22:03:00 | 95 - 117 |
| B46 | Montserrat | 23 February, 1966 | 23:21:00 | 111 - 120 |
| B47 | Nevis | 24 February, 1966 | 00:25:00 | 91 - 122 |
| B48 | Puerto Rico | 24 February, 1966 | 03:27:00 | 90 - 123 |
| B49 | St. Thomas | 24 February, 1966 | 05:23:00 | 96 - 118 |
| B50 | Flamingo | 25 February, 1966 | 18:43:00 | 94 - 130 |

TABULATIONS AND PLOTS

Eight Trail Releases - February 17-25, 1966

TRAIL NO. B43 INAUGUA

BARBADOS 17 FEBRUARY 1966 21-03-00 AST

UP TRAIL

| ALTITUDE (KM) | WIND HEADING (DEG) | WIND VELOCITY (M/S) | WIND COMPONENTS (M/S) GEOGRAPHIC N-S | GEOGRAPHIC E-W | MAGNETIC N-S | MAGNETIC E-W |
|---|---|---|---|---|---|---|
| 92.0 | 299.8 | 97.9 | 48.7 | -85.0 | 64.9 | -73.4 |
| 93.0 | 312.0 | 112.3 | 75.2 | -83.5 | 90.5 | -66.6 |
| 94.0 | 324.7 | 111.4 | 90.9 | -64.4 | 102.0 | -44.7 |
| 95.0 | 337.4 | 112.7 | 104.0 | -43.4 | 110.6 | -21.5 |
| 96.0 | 345.6 | 117.0 | 113.3 | -29.0 | 116.8 | -5.5 |
| 97.0 | 345.5 | 136.8 | 132.4 | -34.1 | 136.6 | -6.7 |
| 98.0 | 344.2 | 143.9 | 138.5 | -39.1 | 143.5 | -10.3 |
| 99.0 | 344.4 | 143.5 | 138.2 | -38.7 | 143.2 | -10.0 |
| 100.0 | 353.7 | 113.7 | 113.0 | -12.5 | 113.2 | 10.6 |
| 101.0 | 6.4 | 105.7 | 105.0 | 11.8 | 100.5 | 32.8 |
| 102.0 | 13.7 | 100.2 | 97.3 | 23.8 | 90.5 | 43.0 |
| 103.0 | 23.0 | 75.2 | 69.2 | 29.4 | 61.8 | 42.8 |
| 104.0 | 31.0 | 62.8 | 53.8 | 32.4 | 46.1 | 42.6 |
| 105.0 | 44.2 | 44.2 | 31.7 | 30.8 | 24.8 | 36.6 |
| 106.0 | 105.0 | 21.6 | -5.6 | 20.9 | -9.7 | 19.3 |
| 107.0 | 161.4 | 17.3 | -16.4 | 5.5 | -17.2 | 2.1 |
| 108.0 | 248.5 | 22.6 | -8.3 | -21.0 | -3.9 | -22.2 |
| 109.0 | 265.1 | 14.9 | -1.3 | -14.8 | 1.7 | -14.8 |
| 110.0 | 336.6 | 18.1 | 16.6 | -7.2 | 17.7 | -3.7 |
| 111.0 | 43.5 | 20.2 | 14.6 | 13.9 | 11.5 | 16.6 |
| 112.0 | 49.0 | 35.9 | 23.5 | 27.1 | 17.5 | 31.3 |
| 113.0 | 63.6 | 53.6 | 23.8 | 48.0 | 13.6 | 51.8 |
| 114.0 | 68.9 | 66.4 | 23.9 | 62.0 | 10.9 | 65.5 |
| 115.0 | 69.8 | 72.2 | 24.9 | 67.8 | 10.7 | 71.4 |
| 116.0 | 71.2 | 79.5 | 25.7 | 75.3 | 10.0 | 78.9 |
| 117.0 | 71.9 | 87.9 | 27.3 | 83.5 | 9.9 | 87.3 |
| 118.0 | 77.6 | 87.0 | 18.7 | 85.0 | 1.2 | 87.0 |
| 119.0 | 88.1 | 81.8 | 2.7 | 81.7 | -13.9 | 80.6 |
| 120.0 | 96.4 | 76.6 | -8.5 | 76.1 | -23.7 | 72.8 |
| 121.0 | 99.8 | 74.9 | -12.7 | 73.8 | -27.3 | 69.7 |
| 122.0 | 102.7 | 75.1 | -16.5 | 73.3 | -31.0 | 68.5 |
| 123.0 | 101.4 | 73.8 | -14.6 | 72.3 | -28.9 | 67.9 |

TRAIL NO. B43 INAUGUA

BARBADOS 17 FEBRUARY 1966 21-03-00 AST

DOWN TRAIL

| ALTITUDE (KM) | WIND HEADING (DEG) | WIND VELOCITY (M/S) | WIND COMPONENTS (M/S) GEOGRAPHIC N-S | GEOGRAPHIC E-W | MAGNETIC N-S | MAGNETIC E-W |
|---|---|---|---|---|---|---|
| 107.0 | 212.4 | 7.5 | -6.3 | -4.0 | -5.4 | -5.2 |
| 108.0 | 221.6 | 20.9 | -15.6 | -13.9 | -12.5 | -16.8 |
| [illegible] | 261.7 | 19.7 | -2.8 | -19.5 | 1.2 | -19.7 |
| 110.0 | 328.7 | 16.2 | 13.8 | -8.4 | 15.2 | -5.4 |
| 111.0 | 19.0 | 16.7 | 15.8 | 5.5 | 14.4 | 8.6 |
| 112.0 | 62.4 | 39.6 | 18.3 | 35.1 | 10.8 | 38.1 |
| 113.0 | 72.2 | 59.4 | 18.2 | 56.6 | 6.4 | 59.1 |
| 114.0 | 76.2 | 67.0 | 16.0 | 65.1 | 2.5 | 67.0 |
| 115.0 | 77.3 | 86.9 | 19.2 | 84.8 | 1.7 | 86.9 |
| 116.0 | 78.4 | 99.8 | 20.0 | 97.7 | -0.1 | 99.7 |
| 117.0 | 80.9 | 101.6 | 16.0 | 100.3 | -4.6 | 101.5 |
| 118.0 | 84.2 | 100.6 | 10.1 | 100.1 | -10.3 | 100.1 |
| 119.0 | 91.4 | 93.7 | -2.2 | 93.7 | -21.1 | 91.3 |
| 120.0 | 94.8 | 94.4 | -8.0 | 94.1 | -26.8 | 90.5 |
| 121.0 | 97.3 | 97.5 | -12.3 | 96.7 | -31.6 | 92.2 |

WIND COMPONENTS

TRAIL NO. B43 INAUGUA

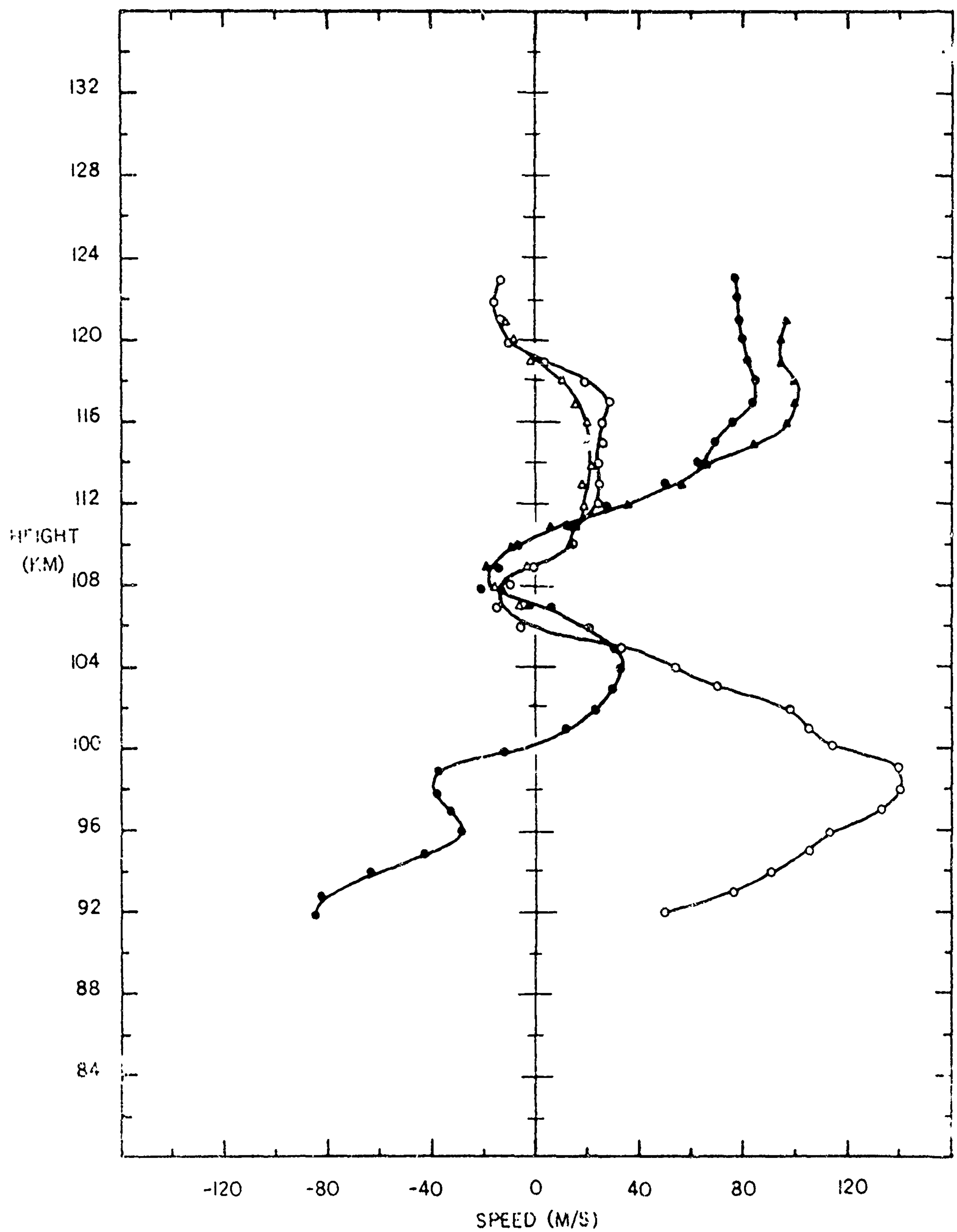
17 FEBRUARY 1966 21:03:00

H.A.R.P. BARBADOS

UP DOWN

O △ NORTH- SOUTH

● ▲ EAST-WEST

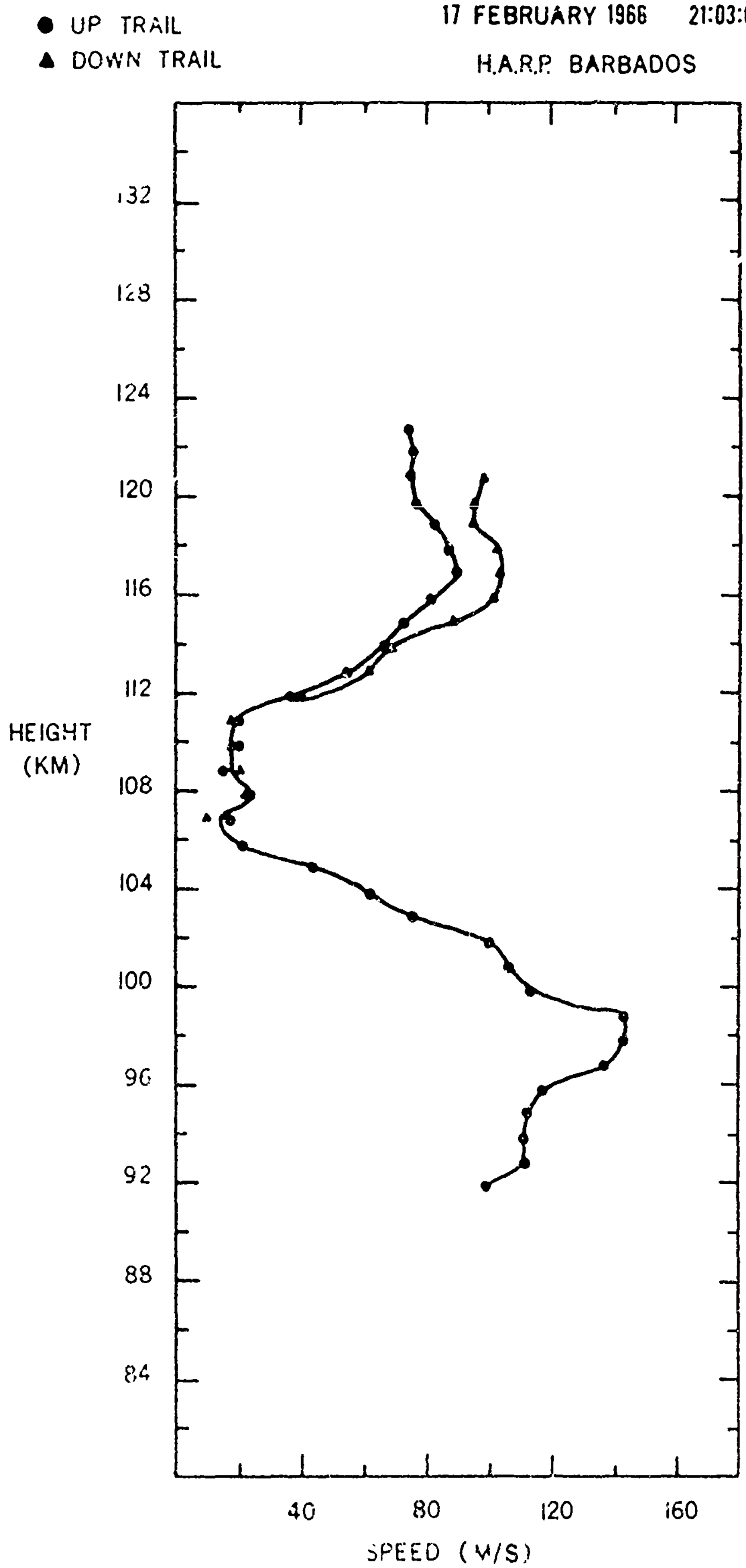


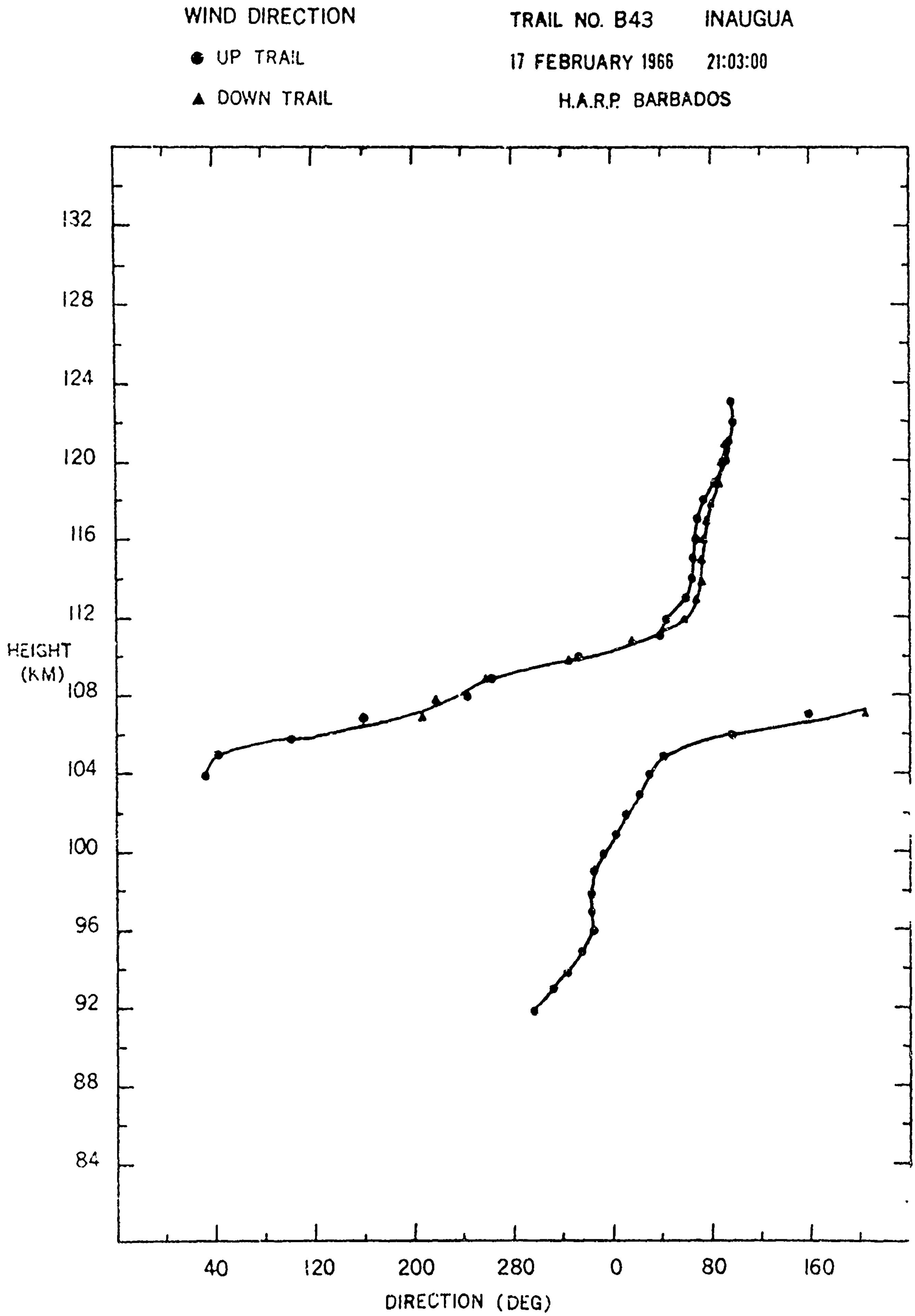
WIND SPEED

TRAIL NO. B43 INAUGUA

17 FEBRUARY 1966 21:03:00

H.A.R.P. BARBADOS



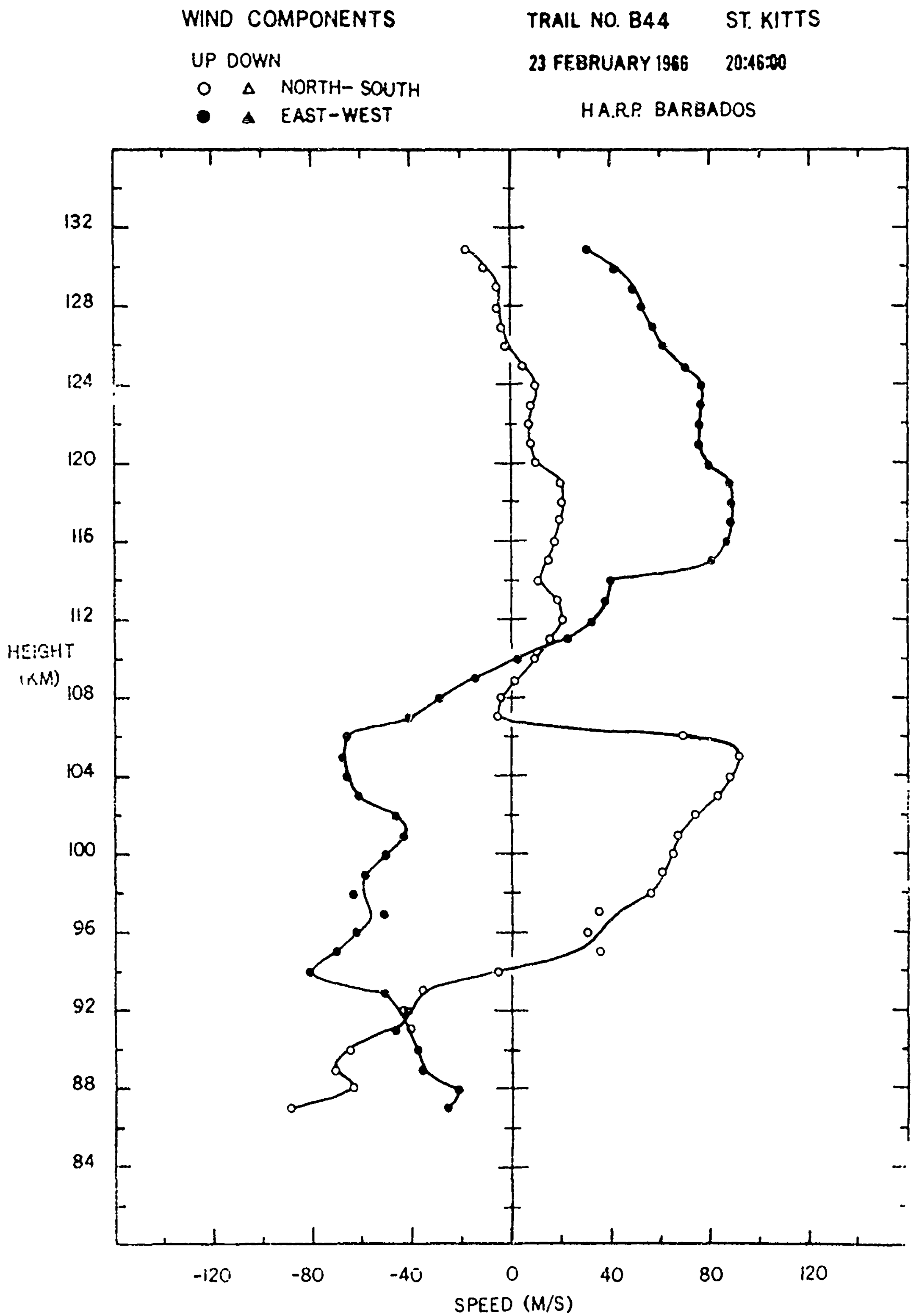


WIND DIRECTION
● UP TRAIL
▲ DOWN TRAIL
TRAIL NO. B43
INAUGUA
17 FEBRUARY 1966
21:03:00
H.A.R.P. BARBADOS
HEIGHT (KM)
132
128
124
120
116
112
108
104
100
96
92
88
84
40
120
200
280
0
80
160
DIRECTION (DEG)

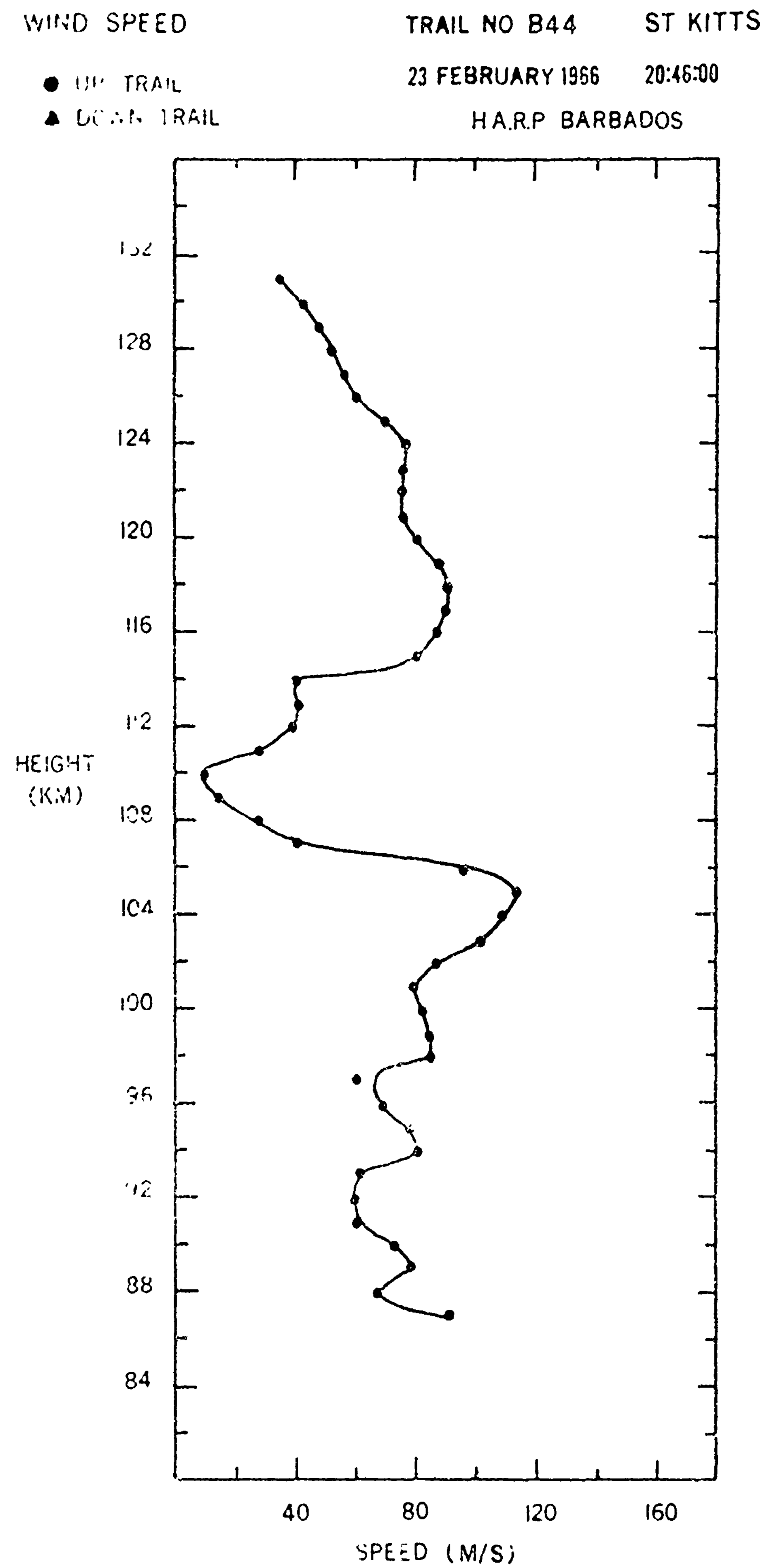
TRAIL NO. 844 ST. KITTS

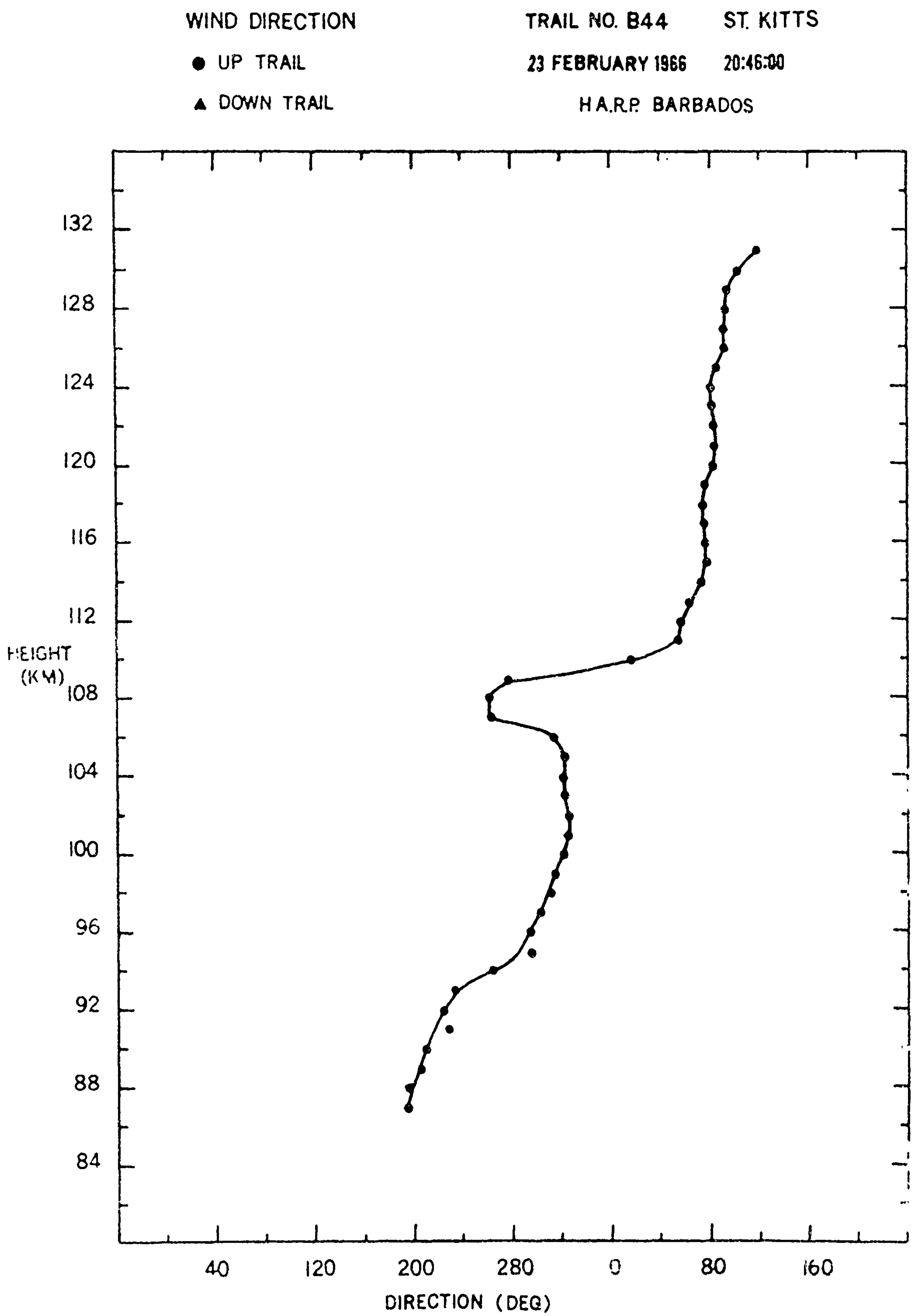
BARBADOS 23 FEBRUARY 1966 20-46-00 AST

| ALTITUDE (KM) | WIND HEADING (DEG) | WIND VELOCITY (M/S) | WIND COMPONENTS (M/S) GEOGRAPHIC N-S | GEOGRAPHIC E-W | MAGNETIC N-S | MAGNETIC E-W |
|---|---|---|---|---|---|---|
| 87.0 | 195.8 | 92.5 | -89.0 | -25.1 | -82.1 | -42.6 |
| 88.0 | 197.7 | 66.9 | -63.7 | -20.4 | -58.3 | -32.8 |
| 89.0 | 206.5 | 79.7 | -71.4 | -35.5 | -62.8 | -49.2 |
| 90.0 | 210.2 | 74.7 | -64.6 | -37.6 | -55.7 | -49.9 |
| 91.0 | 229.2 | 61.4 | -40.2 | -46.5 | -30.0 | -53.7 |
| 92.0 | 224.1 | 60.3 | -43.4 | -42.0 | -34.0 | -49.9 |
| 93.0 | 234.6 | 62.2 | -36.1 | -50.7 | -25.1 | -56.9 |
| 94.0 | 265.7 | 81.5 | -6.1 | -81.2 | 10.4 | -80.8 |
| 95.0 | 297.5 | 78.9 | 36.5 | -70.0 | 49.9 | -61.2 |
| 96.0 | 296.1 | 69.8 | 30.7 | -62.7 | 42.7 | -55.2 |
| 97.0 | 304.5 | 62.1 | 35.2 | -51.1 | 44.8 | -42.9 |
| 98.0 | 311.5 | 85.3 | 56.5 | -63.9 | 68.2 | -51.2 |
| 99.0 | 316.7 | 85.0 | 61.8 | -58.3 | 72.3 | -44.6 |
| 100.0 | 321.9 | 82.6 | 65.0 | -50.9 | 73.9 | -36.7 |
| 101.0 | 327.1 | 79.7 | 66.9 | -43.2 | 74.2 | -28.8 |
| 102.0 | 328.2 | 87.6 | 74.4 | -46.2 | 82.2 | -30.2 |
| 103.0 | 323.5 | 103.4 | 83.2 | -61.5 | 93.9 | -43.4 |
| 104.0 | 323.1 | 109.8 | 87.7 | -65.9 | 99.2 | -46.8 |
| 105.0 | 323.3 | 114.1 | 91.5 | -68.2 | 103.4 | -48.3 |
| 106.0 | 316.4 | 95.6 | 69.2 | -66.0 | 81.1 | -50.7 |
| 107.0 | 263.2 | 41.0 | -4.9 | -40.7 | 3.4 | -40.9 |
| 108.0 | 262.1 | 28.8 | -4.0 | -28.5 | 1.8 | -28.7 |
| 109.0 | 278.7 | 15.0 | 2.3 | -14.8 | 5.2 | -14.0 |
| 110.0 | 18.0 | 10.4 | 9.8 | 3.2 | 9.0 | 5.1 |
| 111.0 | 55.1 | 28.6 | 16.3 | 23.5 | 11.2 | 26.3 |
| 112.0 | 57.5 | 39.8 | 21.4 | 33.6 | 14.2 | 37.2 |
| 113.0 | 64.1 | 42.7 | 18.7 | 38.4 | 10.6 | 41.4 |
| 114.0 | 73.5 | 41.7 | 11.9 | 40.0 | 3.6 | 41.6 |
| 115.0 | 79.3 | 82.5 | 15.2 | 81.1 | -1.5 | 82.5 |
| 116.0 | 78.5 | 88.7 | 17.6 | 87.0 | -0.3 | 88.8 |
| 117.0 | 77.3 | 90.2 | 19.9 | 88.0 | 1.7 | 90.2 |
| 118.0 | 76.4 | 91.5 | 21.5 | 88.9 | 3.1 | 91.4 |
| 119.0 | 76.9 | 89.3 | 20.3 | 87.0 | 2.3 | 89.3 |
| 120.0 | 82.2 | 80.8 | 11.0 | 80.0 | -5.4 | 80.6 |
| 121.0 | 83.7 | 76.4 | 8.3 | 76.0 | -7.2 | 76.1 |
| 122.0 | 84.4 | 76.6 | 7.5 | 76.3 | -8.1 | 76.2 |
| 123.0 | 83.5 | 77.1 | 8.7 | 76.7 | -7.0 | 76.9 |
| 124.0 | 82.5 | 77.6 | 10.1 | 77.0 | -5.7 | 77.5 |
| 125.0 | 85.8 | 70.9 | 5.1 | 70.7 | -9.3 | 70.3 |
| 126.0 | 91.1 | 62.1 | -1.2 | 62.0 | -13.7 | 60.5 |
| 127.0 | 92.9 | 57.7 | -3.0 | 57.6 | -14.6 | 55.8 |
| 128.0 | 95.3 | 53.0 | -4.9 | 52.8 | -15.5 | 50.7 |
| 129.0 | 96.1 | 49.5 | -5.3 | 49.3 | -15.1 | 47.2 |
| 130.0 | 104.7 | 43.4 | -11.0 | 42.0 | -19.3 | 38.9 |
| 131.0 | 119.9 | 35.1 | 17.5 | 30.4 | -23.3 | 26.[illegible] |



WIND COMPONENTS
UP DOWN
NORTH- SOUTH
EAST-WEST
TRAIL NO. B44
ST. KITTS
23 FEBRUARY 1966
20:46:00
H.A.R.P. BARBADOS
HEIGHT (KM)
132
128
124
120
116
112
108
104
100
96
92
88
84
-120
-80
-40
0
40
80
120
SPEED (M/S)


WIND SPEED
TRAIL NO B44
ST KITTS
UP TRAIL
DOWN TRAIL
23 FEBRUARY 1966
20:46:00
H.A.R.P BARBADOS
HEIGHT (KM)
132
128
124
120
116
112
108
104
100
96
92
88
84
40
80
120
160
SPEED (M/S)

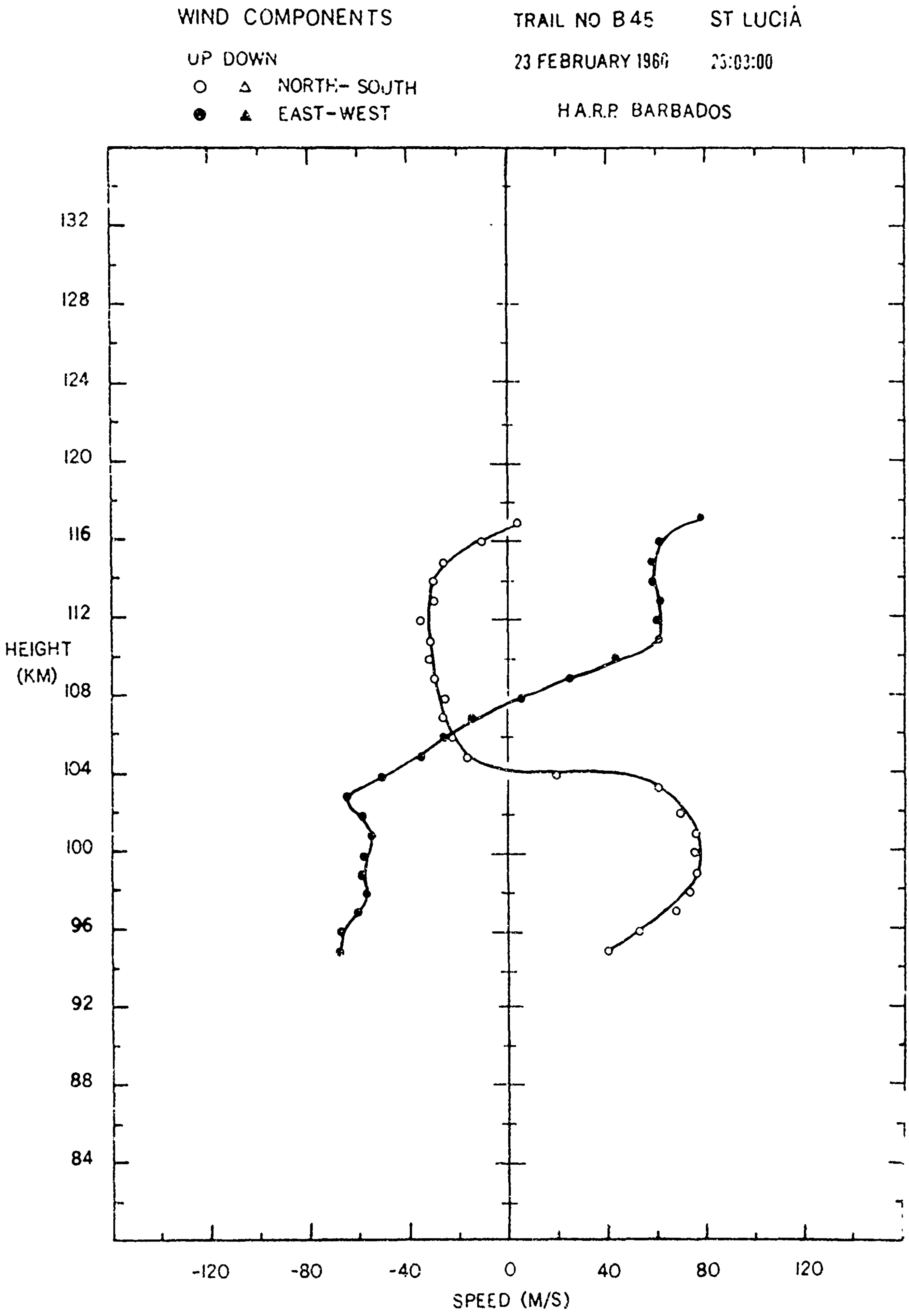


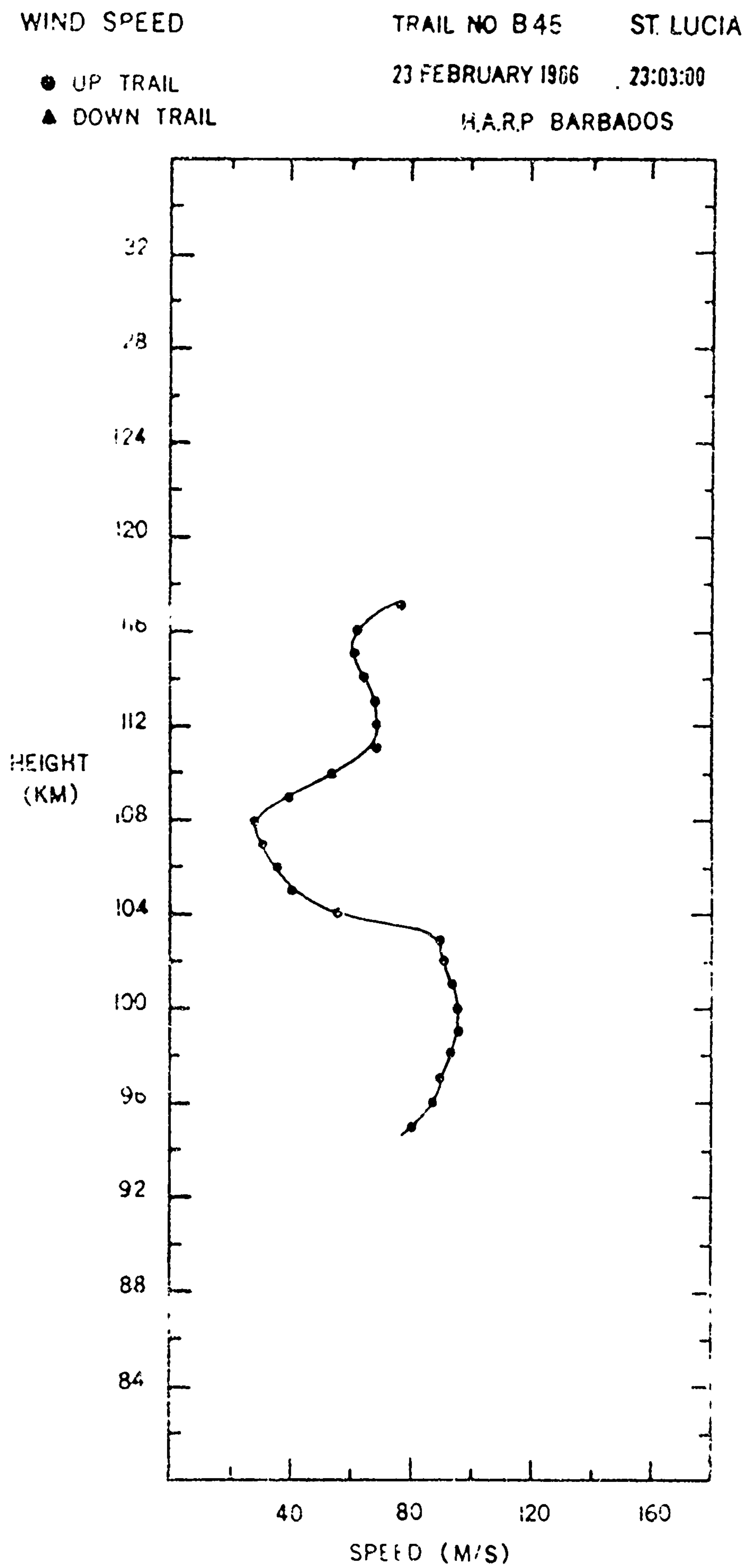
WIND DIRECTION
● UP TRAIL
▲ DOWN TRAIL
TRAIL NO. B44
ST. KITTS
23 FEBRUARY 1966
20:46:00
H.A.R.P. BARBADOS
HEIGHT (KM)
132
128
124
120
116
112
108
104
100
96
92
88
84
40
120
200
280
0
80
160
DIRECTION (DEG)

TRAIL NO. 845 ST. LUCIA

BARBADOS 23 FEBRUARY 1966 22-03-00 AST

| ALTITUDE (KM) | WIND HEADING (DEG) | WIND VELOCITY (M/S) | WIND COMPONENTS (M/S) GEOGRAPHIC N-S | E-W | MAGNETIC N-S | E-W |
|---|---|---|---|---|---|---|
| 95.0 | 300.6 | 78.4 | 39.9 | -67.5 | 52.7 | -58.1 |
| 96.0 | 308.6 | 86.4 | 53.9 | -67.5 | 66.4 | -55.2 |
| 97.0 | 318.6 | 90.6 | 68.0 | -59.9 | 78.7 | -44.9 |
| 98.0 | 322.1 | 92.9 | 73.2 | -57.1 | 83.2 | -41.1 |
| 99.0 | 321.9 | 95.5 | 75.2 | -58.9 | 85.5 | -42.5 |
| 100.0 | 321.7 | 95.0 | 74.6 | -58.9 | 85.0 | -42.6 |
| 101.0 | 323.6 | 93.9 | 75.6 | -55.7 | 85.3 | -39.3 |
| 102.0 | 319.5 | 90.6 | 68.9 | -58.9 | 79.4 | -43.8 |
| 103.0 | 313.0 | 89.4 | 60.9 | -65.4 | 72.9 | -51.8 |
| 104.0 | 290.8 | 55.4 | 19.7 | -51.8 | 29.8 | -46.8 |
| 105.0 | 244.6 | 39.7 | -17.0 | -35.9 | -9.4 | -38.6 |
| 106.0 | 229.5 | 34.6 | -22.5 | -26.3 | -16.7 | -30.3 |
| 107.0 | 209.1 | 30.3 | -26.4 | -14.7 | -22.9 | -19.7 |
| 108.0 | 168.4 | 26.3 | -25.8 | 5.3 | -26.3 | 0.0 |
| 109.0 | 140.3 | 38.9 | -29.9 | 24.9 | -34.3 | 18.3 |
| 110.0 | 126.1 | 53.8 | -31.7 | 43.5 | -39.8 | 36.2 |
| 111.0 | 117.4 | 68.8 | -31.7 | 61.1 | -43.4 | 53.4 |
| 112.0 | 120.4 | 69.2 | -35.0 | 59.7 | -46.3 | 51.4 |
| 113.0 | 115.4 | 69.1 | -29.6 | 62.4 | -41.6 | 55.1 |
| 114.0 | 117.1 | 65.4 | -29.8 | 58.2 | -40.9 | 51.0 |
| 115.0 | 115.3 | 62.2 | -26.6 | 56.2 | -37.4 | 49.7 |
| 116.0 | 99.9 | 62.7 | -10.8 | 61.8 | -23.1 | 58.3 |
| 117.0 | 87.0 | 77.3 | 4.0 | 77.2 | -11.7 | 76.4 |


WIND COMPONENTS
UP DOWN
NORTH- SOUTH
EAST-WEST
TRAIL NO B45
ST LUCIA
23 FEBRUARY 1966
23:03:00
H.A.R.P. BARBADOS
HEIGHT (KM)
132
128
124
120
116
112
108
104
100
96
92
88
84
-120
-80
-40
0
40
80
120
SPEED (M/S)


WIND SPEED
TRAIL NO B45
ST. LUCIA
● UP TRAIL
▲ DOWN TRAIL
23 FEBRUARY 1966
23:03:00
H.A.R.P BARBADOS
124
120
112
HEIGHT (KM)
108
104
100
92
88
84
40
80
120
160
SPEED (M/S)

WIND DIRECTION

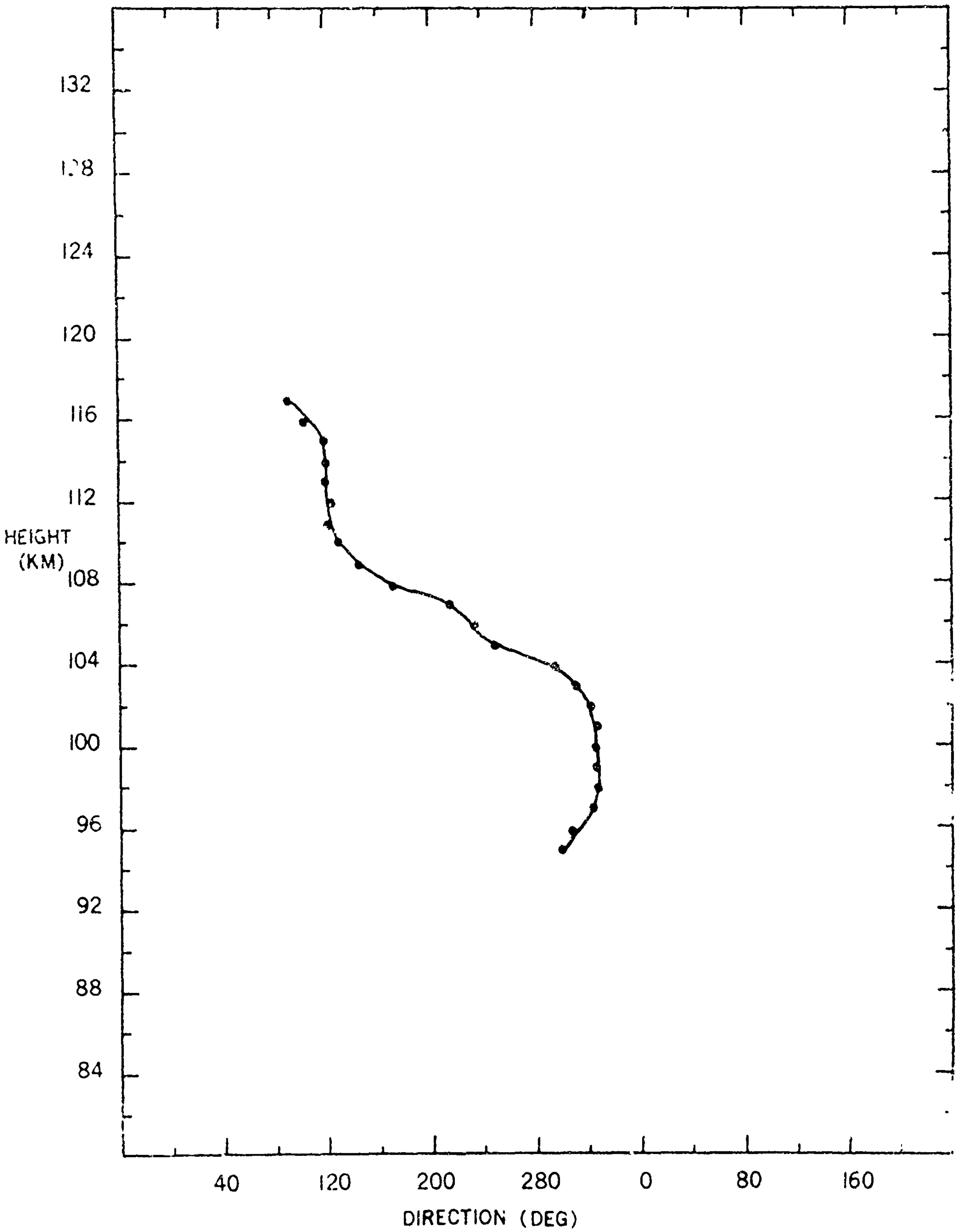
● UP TRAIL

▲ DOWN TRAIL

TRAIL NO. B 45 ST LUCIA

23 FEBRUARY 1966 23:03:00

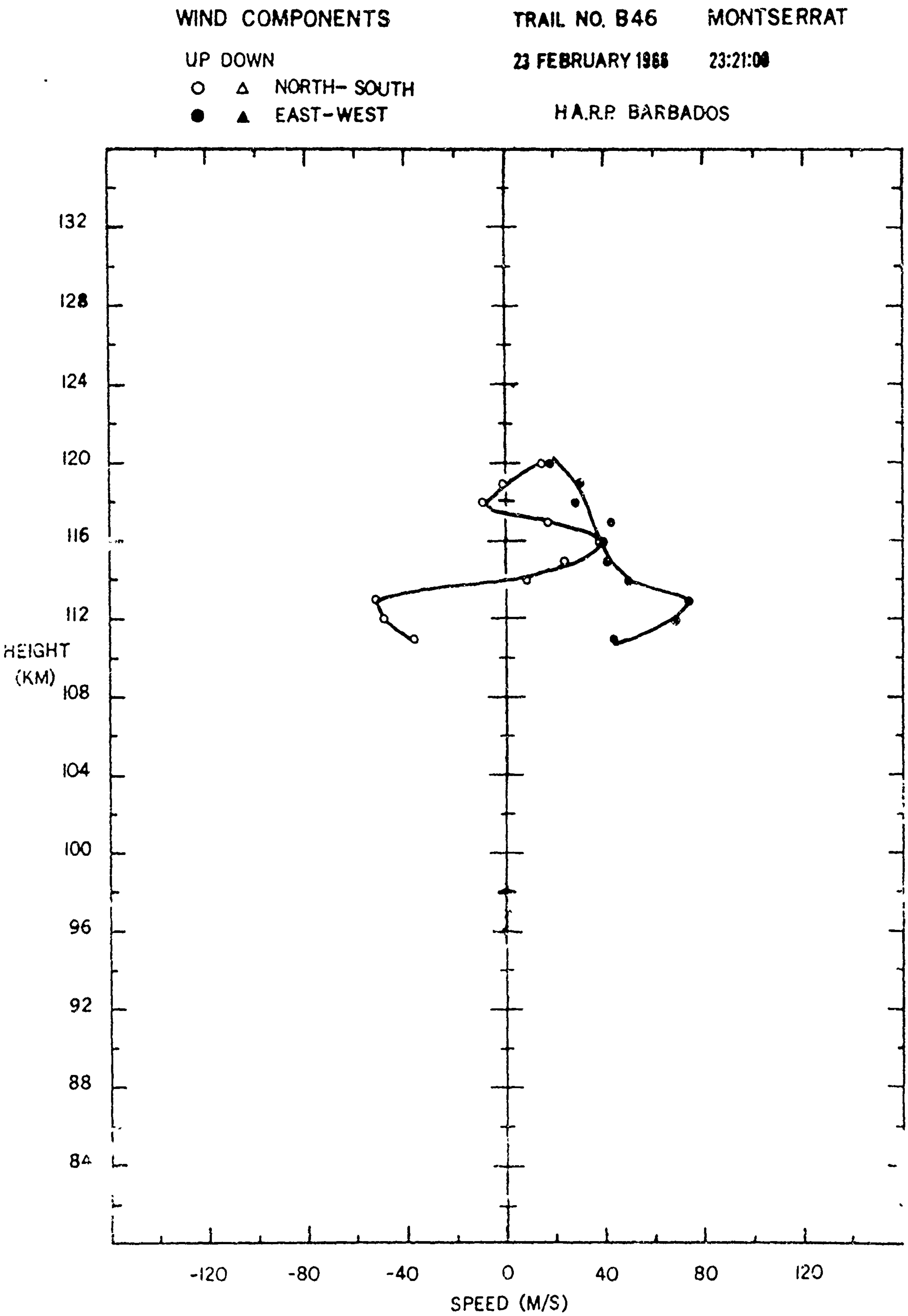
H.A.R.P. BARBADOS



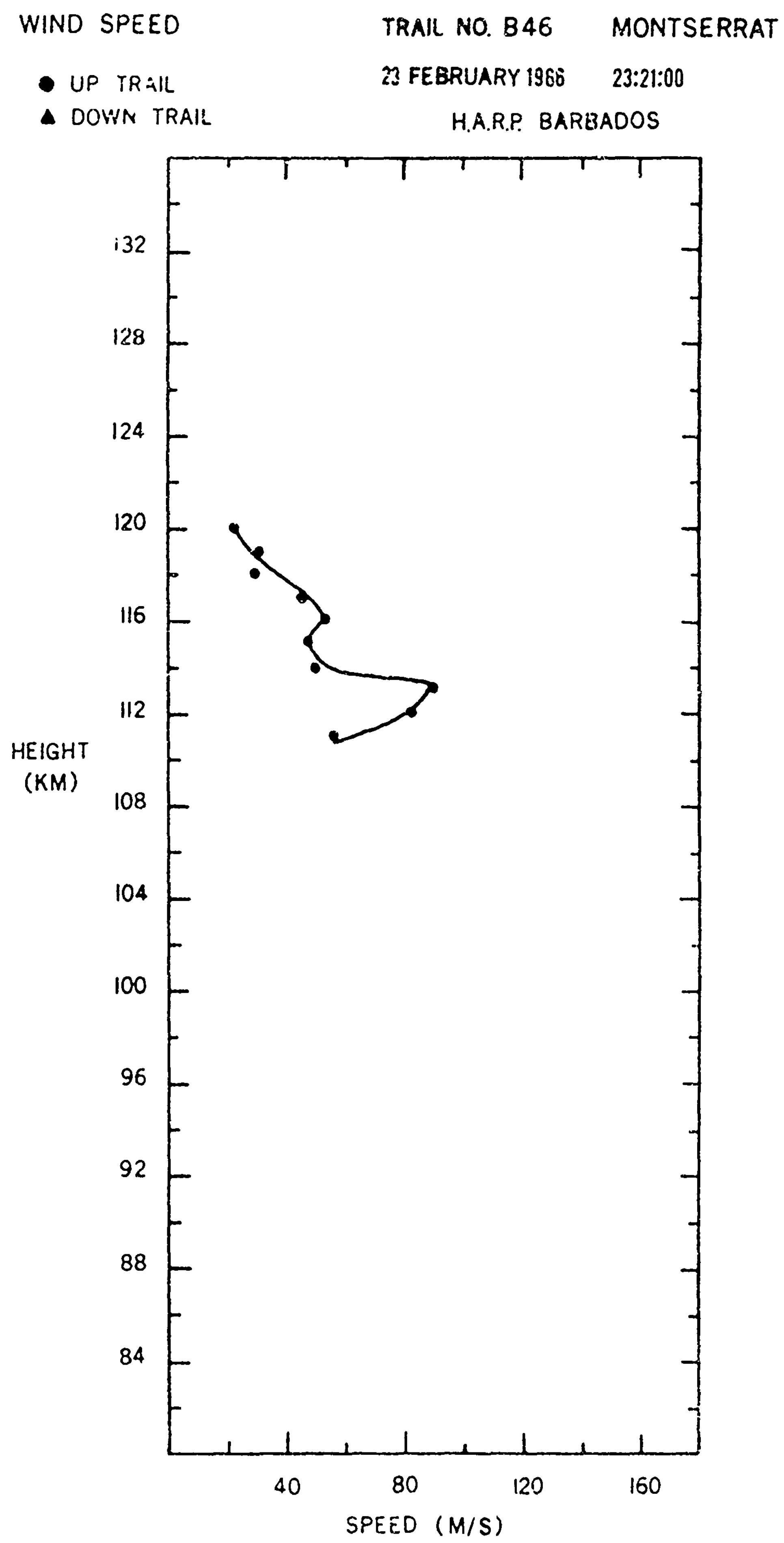
TRAIL NO. B46 MONTSERRAT

BARBADOS — 23 FEBRUARY 1966 — 23-21-00 AST

| ALTITUDE | WIND HEADING | WIND VELOCITY | WIND COMPONENTS (M/S) GEOGRAPHIC | | MAGNETIC | |
|---|---|---|---|---|---|---|
| (KM) | (DEG) | (M/S) | N-S | E-W | N-S | E-W |
| 111.0 | 128.9 | 57.4 | -36.0 | 44.7 | -44.3 | 36.5 |
| 112.0 | 124.7 | 84.8 | -48.3 | 69.7 | -61.4 | 58.5 |
| 113.0 | 125.2 | 91.2 | -52.6 | 74.5 | -66.6 | 62.3 |
| 114.0 | 80.2 | 51.0 | 8.7 | 50.3 | -1.6 | 51.0 |
| 115.0 | 59.6 | 48.6 | 24.6 | 41.9 | 15.6 | 46.0 |
| 116.0 | 45.2 | 54.8 | 38.6 | 38.9 | 29.9 | 45.9 |
| 117.0 | 67.9 | 46.7 | 17.6 | 43.3 | 8.5 | 46.0 |
| 118.0 | 105.8 | 30.2 | -8.2 | 29.1 | -13.9 | 26.8 |
| 119.0 | 91.2 | 31.5 | -0.7 | 31.4 | -7.0 | 30.6 |
| 120.0 | 50.3 | 23.4 | 15.0 | 18.0 | 11.1 | 20.7 |



WIND COMPONENTS
TRAIL NO. B46
MONTSERRAT
UP DOWN
23 FEBRUARY 1966
23:21:00
NORTH-SOUTH
EAST-WEST
H.A.R.P. BARBADOS
HEIGHT (KM)
132
128
124
120
116
112
108
104
100
96
92
88
84
-120
-80
-40
0
40
80
120
SPEED (M/S)


WIND SPEED
TRAIL NO. B46
MONTSERRAT
● UP TRAIL
▲ DOWN TRAIL
23 FEBRUARY 1966
23:21:00
H.A.R.P. BARBADOS
HEIGHT (KM)
132
128
124
120
116
112
108
104
100
96
92
88
84
40
80
120
160
SPEED (M/S)

WIND DIRECTION

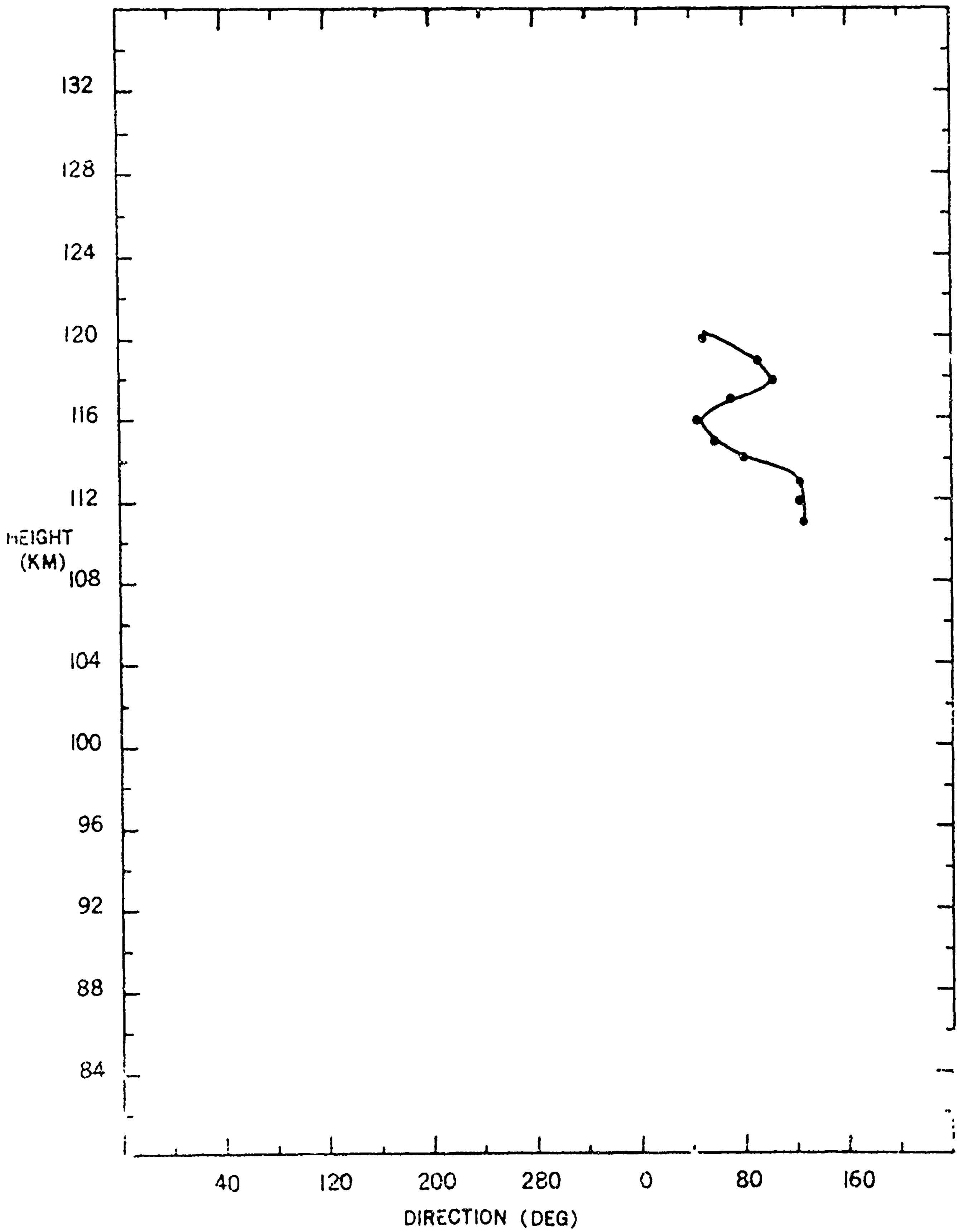
● UP TRAIL

▲ DOWN TRAIL

TRAIL NO. B46 MONTSERRAT

23 FEBRUARY 1966 23:21:00

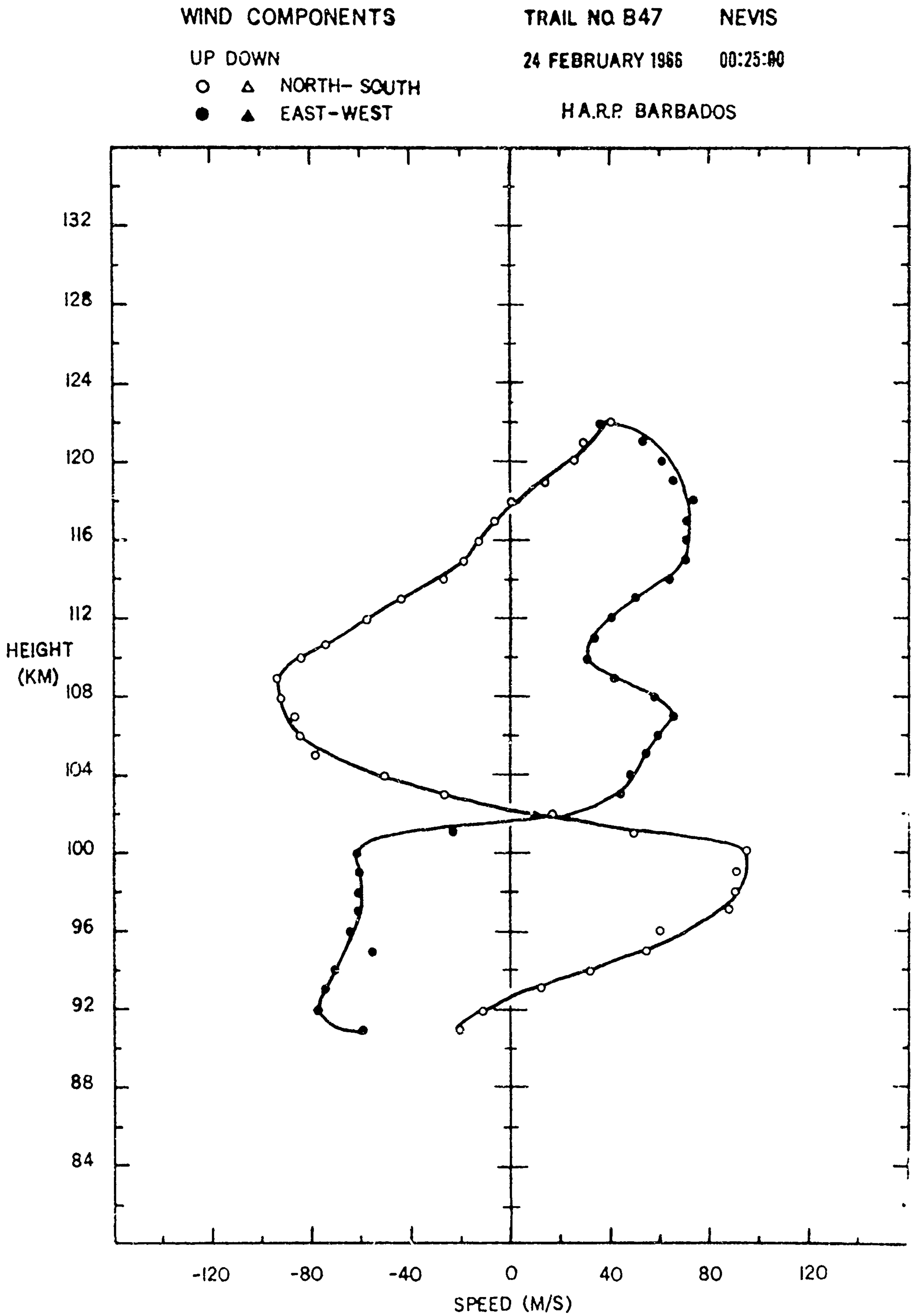
H.A.R.P. BARBADOS



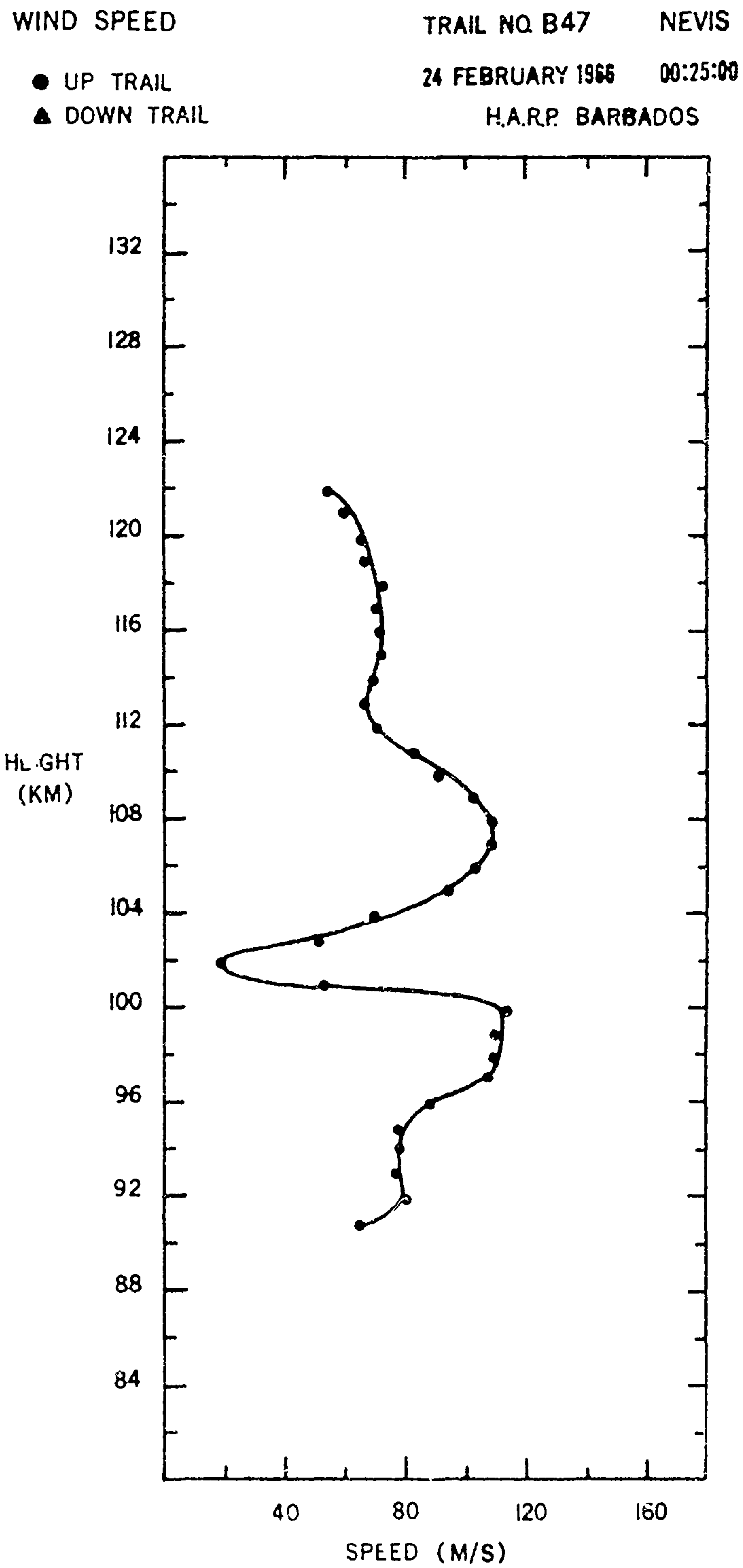
TRAIL NO. B47 NEVIS

BARBADOS 24 FEBRUARY 1966 00-25-00 AST

| ALTITUDE (KM) | WIND HEADING (DEG) | WIND VELOCITY (M/S) | WIND COMPONENTS (M/S) GEOGRAPHIC N-S | GEOGRAPHIC E-W | MAGNETIC N-S | MAGNETIC E-W |
|---|---|---|---|---|---|---|
| 91.0 | 250.5 | 64.4 | -21.5 | -60.7 | -8.8 | -63.8 |
| 92.0 | 261.0 | 80.0 | -12.6 | -79.0 | 3.6 | -79.9 |
| 93.0 | 279.1 | 76.1 | 12.1 | -75.1 | 27.0 | -71.[illegible] |
| 94.0 | 294.2 | 78.4 | 32.1 | -71.5 | 45.9 | -53.[illegible] |
| 95.0 | 313.4 | 77.8 | 53.5 | -56.5 | 63.8 | -44.[illegible] |
| 96.0 | 312.6 | 88.6 | 60.0 | -65.2 | 71.9 | -51.7 |
| 97.0 | 325.0 | 107.9 | 88.4 | -61.9 | 99.1 | -42.8 |
| 98.0 | 324.9 | 108.9 | 89.2 | -62.6 | 100.0 | -4[illegible].3 |
| 99.0 | 325.6 | 109.6 | 90.4 | -62.0 | 101.1 | -42.5 |
| 100.0 | 326.3 | 114.5 | 95.2 | -63.6 | 106.1 | -43.1 |
| 101.0 | 334.8 | 53.9 | 48.8 | -22.9 | 52.4 | -12.6 |
| 102.0 | 27.3 | 17.8 | 15.8 | 8.1 | 13.8 | 11.1 |
| 103.0 | 122.3 | 51.4 | -27.5 | 43.4 | -35.7 | 37.0 |
| 104.0 | 138.5 | 69.6 | -52.1 | 46.2 | -60.4 | 34.7 |
| 105.0 | 145.2 | 94.5 | -77.6 | 53.9 | -86.9 | 37.1 |
| 106.0 | 146.1 | 103.6 | -86.0 | 57.8 | -95.9 | 39.2 |
| 107.0 | 143.5 | 108.9 | -87.5 | 64.8 | -98.8 | 45.8 |
| 108.0 | 148.4 | 108.9 | -92.8 | 57.0 | -102.4 | 37.1 |
| 109.0 | 156.8 | 103.0 | -94.6 | 40.6 | -100.8 | 20.7 |
| 110.0 | 160.6 | 91.1 | -85.9 | 30.3 | -90.2 | 12.3 |
| 111.0 | 156.7 | 83.0 | -76.3 | 32.9 | -81.4 | 16.8 |
| 112.0 | 145.1 | 70.7 | -58.0 | 40.5 | -65.0 | 28.0 |
| 113.0 | 131.7 | 66.4 | -44.2 | 49.6 | -53.3 | 39.7 |
| 114.0 | 113.0 | 69.2 | -27.1 | 63.7 | -39.4 | 56.9 |
| 115.0 | 105.2 | 72.2 | -19.0 | 69.7 | -32.7 | 64.4 |
| 116.0 | 101.0 | 71.9 | -13.7 | 70.5 | -27.7 | 66.3 |
| 117.0 | 95.7 | 70.9 | -7.1 | 70.5 | -21.2 | 67.6 |
| 118.0 | 89.5 | 73.7 | 0.6 | 73.7 | -14.3 | 72.3 |
| 119.0 | 78.5 | 66.3 | 13.3 | 65.0 | -0.1 | 66.3 |
| 120.0 | 66.9 | 65.8 | 25.9 | 60.5 | 13.1 | 64.5 |
| 121.0 | 61.6 | 59.8 | 28.5 | 52.6 | 17.3 | 57.3 |
| 122.0 | 41.2 | 53.9 | 40.5 | 35.5 | 32.5 | 42.9 |



WIND COMPONENTS
TRAIL NO. B47
NEVIS
UP DOWN
24 FEBRUARY 1966
00:25:00
NORTH- SOUTH
EAST-WEST
H.A.R.P. BARBADOS
HEIGHT (KM)
132
128
124
120
116
112
108
104
100
96
92
88
84
-120
-80
-40
0
40
80
120
SPEED (M/S)



WIND SPEED
TRAIL NO. B47
NEVIS
● UP TRAIL
▲ DOWN TRAIL
24 FEBRUARY 1966
00:25:00
H.A.R.P. BARBADOS
132
128
124
120
116
112
108
104
100
96
92
88
84
HEIGHT (KM)
40
80
120
160
SPEED (M/S)

WIND DIRECTION

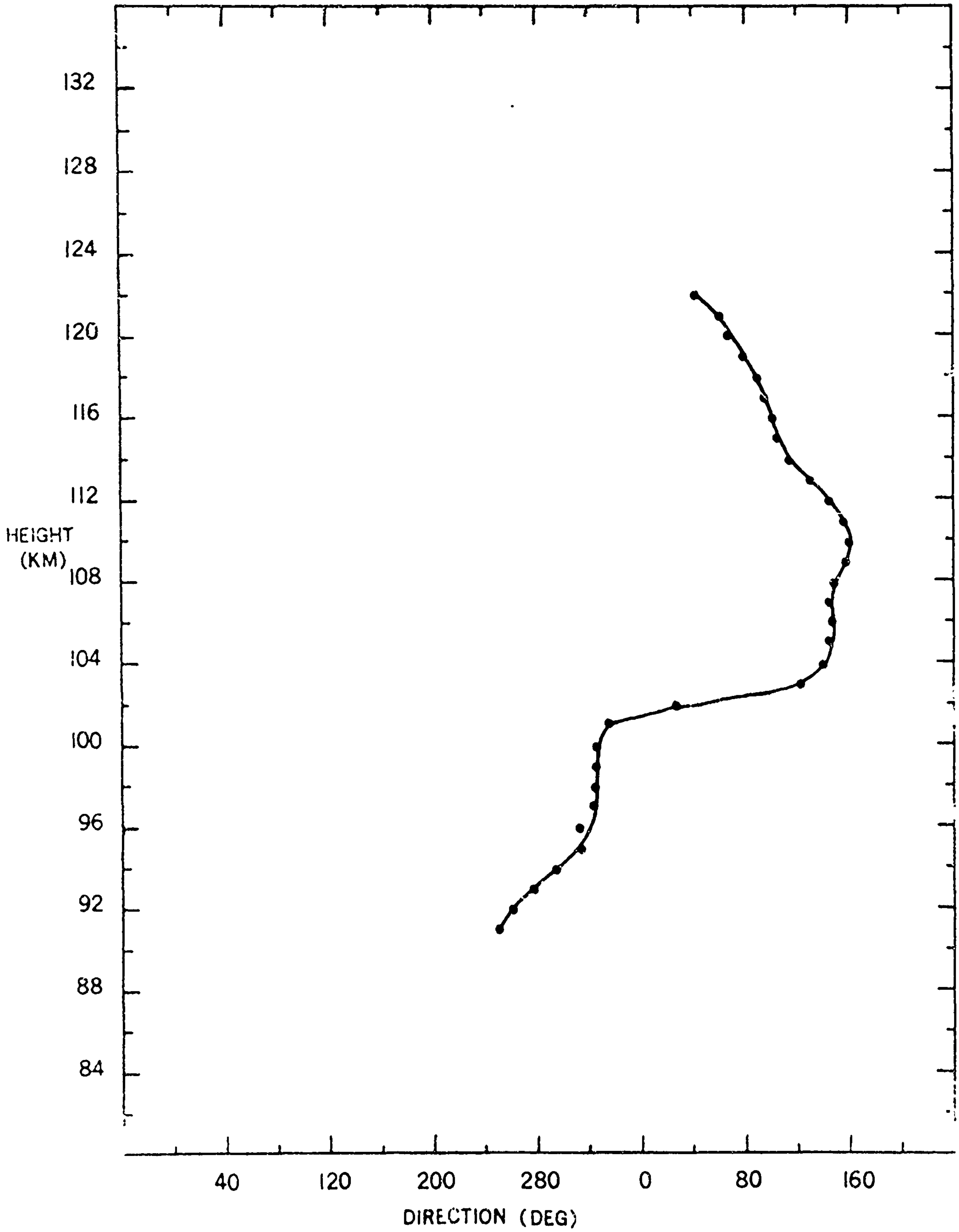
● UP TRAIL

▲ DOWN TRAIL

TRAIL NO. B47 NEVIS

24 FEBRUARY 1966 00:25:00

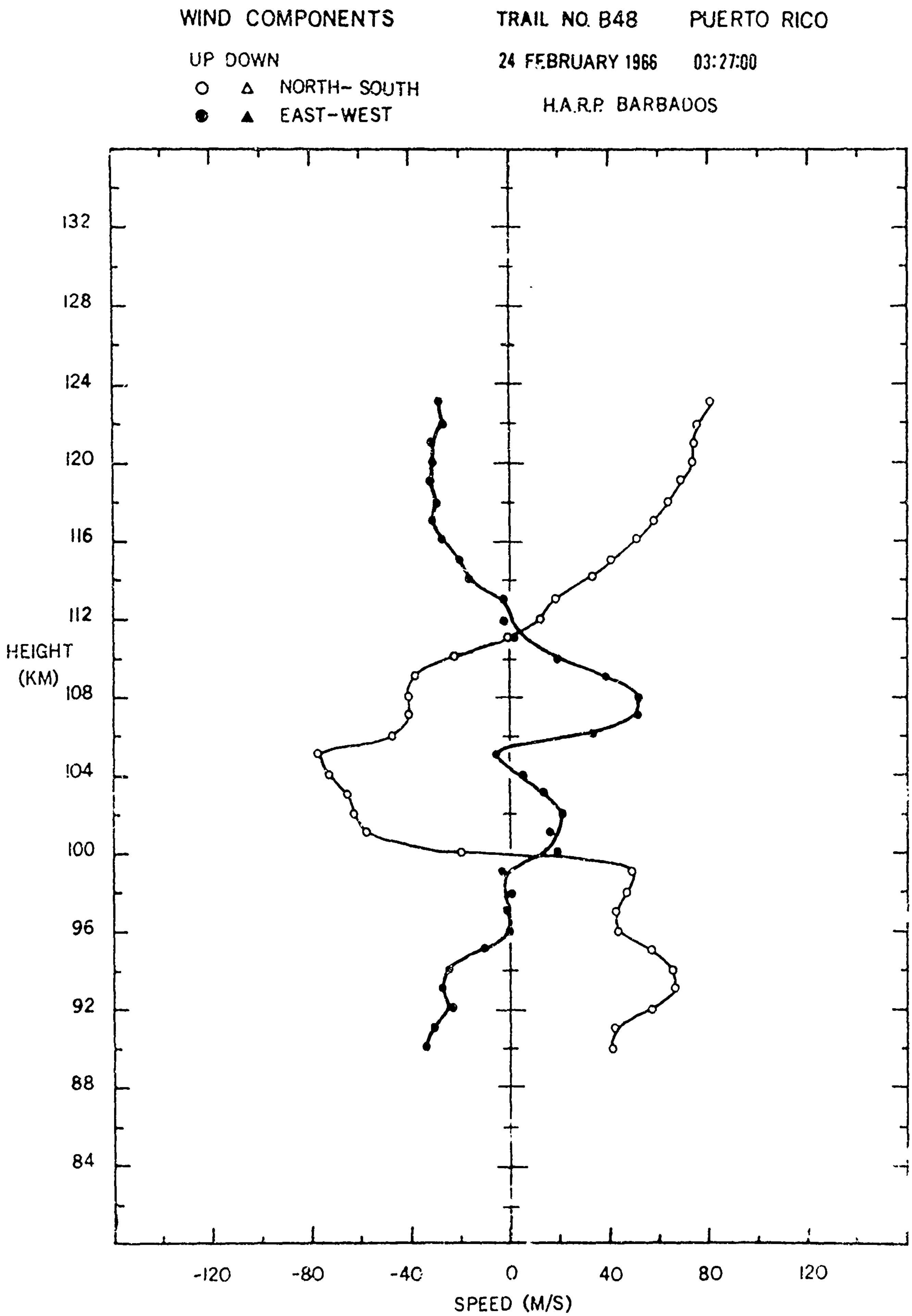
H.A.R.P. BARBADOS

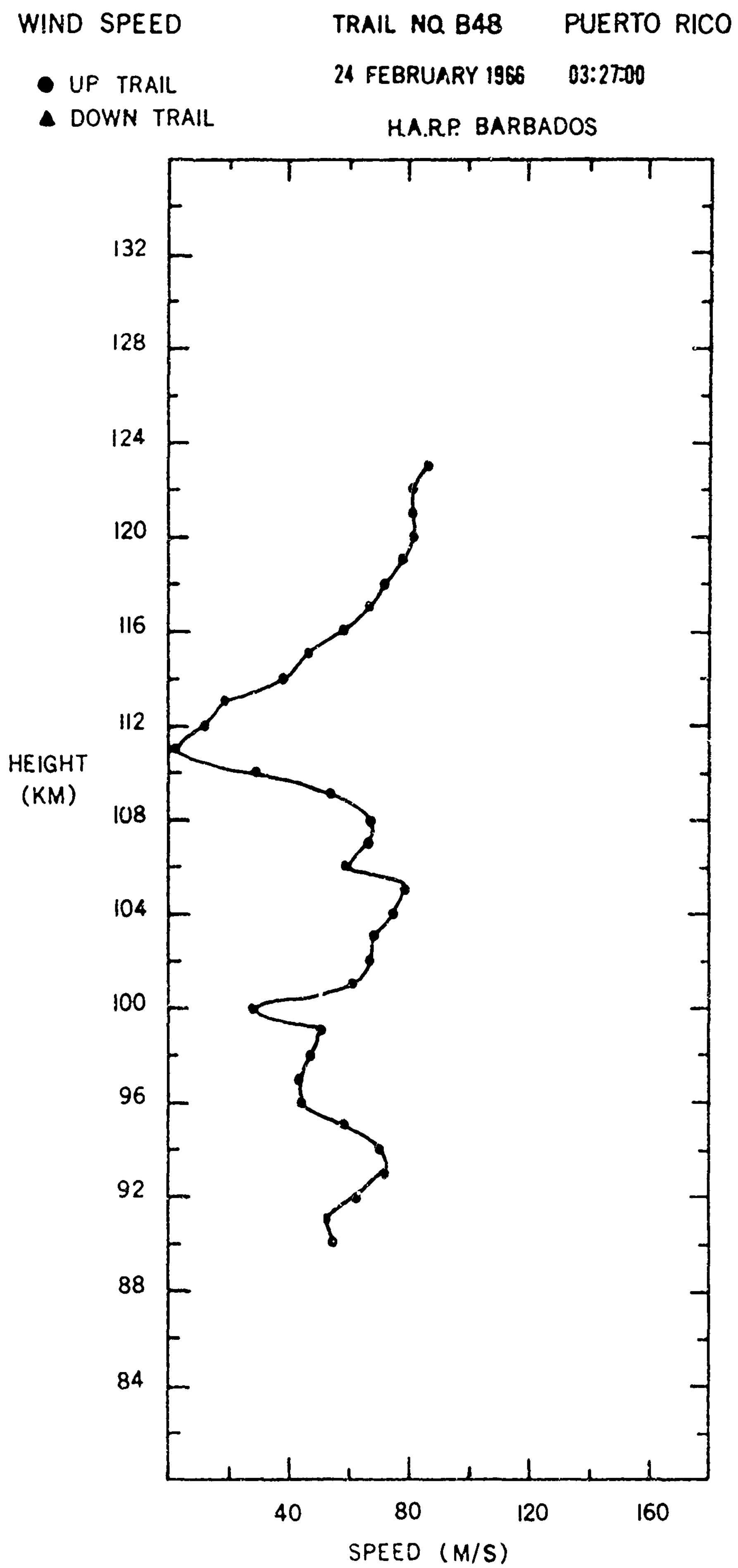


TRAIL NO. 848 PUERTO RICO

BARBADOS 24 FEBRUARY 1966 03-27-00 AST

| ALTITUDE | WIND HEADING | WIND VELOCITY | WIND COMPONENTS (M/S) GEOGRAPHIC | | MAGNETIC | |
|---|---|---|---|---|---|---|
| (KM) | (DEG) | (M/S) | N-S | E-W | N-S | E-W |
| 90.0 | 320.1 | 53.7 | 41.2 | -34.4 | 47.3 | -25.4 |
| 91.0 | 324.6 | 52.7 | 43.0 | -30.5 | 48.3 | -21.2 |
| 92.0 | 338.2 | 62.2 | 57.8 | -23.1 | 61.3 | -11.0 |
| 93.0 | 337.4 | 71.6 | 66.1 | -27.6 | 70.3 | -13.7 |
| 94.0 | 339.2 | 70.3 | 65.7 | -25.0 | 69.4 | -11.2 |
| 95.0 | 349.5 | 58.1 | 57.2 | -10.6 | 58.2 | 1.2 |
| 96.0 | 1.1 | 43.9 | 43.9 | 0.9 | 42.8 | 9.7 |
| 97.0 | 357.9 | 43.2 | 43.2 | -1.6 | 42.6 | 7.2 |
| 98.0 | 0.2 | 46.6 | 46.6 | 0.1 | 45.6 | 9.5 |
| 99.0 | 355.8 | 49.8 | 49.7 | -3.7 | 49.4 | 6.4 |
| 100.0 | 137.7 | 27.1 | -20.0 | 18.2 | -23.3 | 13.8 |
| 101.0 | 164.8 | 60.4 | -58.3 | 15.8 | -60.3 | 3.7 |
| 102.0 | 162.0 | 67.2 | -64.0 | 20.6 | -66.8 | 7.3 |
| 103.0 | 168.6 | 67.6 | -66.3 | 13.3 | -67.6 | -0.4 |
| 104.0 | 176.2 | 74.7 | -74.5 | 5.0 | -74.0 | -10.1 |
| 105.0 | 184.3 | 78.8 | -78.6 | -6.0 | -75.8 | -21.7 |
| 106.0 | 145.9 | 58.8 | -48.7 | 32.9 | -54.3 | 22.4 |
| 107.0 | 129.0 | 66.2 | -41.7 | 51.4 | -51.2 | 41.9 |
| 108.0 | 128.7 | 66.9 | -41.9 | 52.2 | -51.6 | 42.7 |
| 109.0 | 135.9 | 54.7 | -39.3 | 38.1 | -46.2 | 29.4 |
| 110.0 | 139.5 | 29.2 | -22.2 | 18.9 | -25.6 | 14.0 |
| 111.0 | 96.4 | 1.3 | -0.1 | 1.2 | -0.3 | 1.2 |
| 112.0 | 352.7 | 12.2 | 12.1 | -1.5 | 12.2 | 1.0 |
| 113.0 | 352.5 | 18.5 | 18.4 | -2.4 | 18.5 | 1.4 |
| 114.0 | 333.8 | 38.4 | 34.5 | -17.0 | 37.2 | -9.7 |
| 115.0 | 333.2 | 45.4 | 40.6 | -20.5 | 43.9 | -11.9 |
| 116.0 | 331.1 | 58.2 | 51.0 | -28.2 | 55.6 | -17.3 |
| 117.0 | 331.0 | 65.8 | 57.6 | -31.9 | 62.9 | -19.6 |
| 118.0 | 335.7 | 71.1 | 64.8 | -29.3 | 69.4 | -15.6 |
| 119.0 | 334.8 | 77.0 | 69.7 | -32.8 | 74.9 | -18.0 |
| 120.0 | 337.1 | 80.8 | 74.4 | -31.4 | 79.2 | -15.7 |
| 121.0 | 336.9 | 80.6 | 74.2 | -31.7 | 79.1 | -16.1 |
| 122.0 | 340.3 | 79.9 | 75.3 | -26.9 | 79.2 | -11.1 |
| 123.0 | 339.8 | 86.1 | 80.8 | -29.7 | 85.1 | -12.8 |


WIND COMPONENTS
TRAIL NO. B48
PUERTO RICO
UP DOWN
24 FEBRUARY 1966
03:27:00
NORTH- SOUTH
EAST-WEST
H.A.R.P. BARBADOS
HEIGHT (KM)
132
128
124
120
116
112
108
104
100
96
92
88
84
-120
-80
-40
0
40
80
120
SPEED (M/S)



WIND SPEED
TRAIL NO. B48
PUERTO RICO
24 FEBRUARY 1966
03:27:00
H.A.R.P. BARBADOS
● UP TRAIL
▲ DOWN TRAIL
HEIGHT (KM)
132
128
124
120
116
112
108
104
100
96
92
88
84
40
80
120
160
SPEED (M/S)

WIND DIRECTION

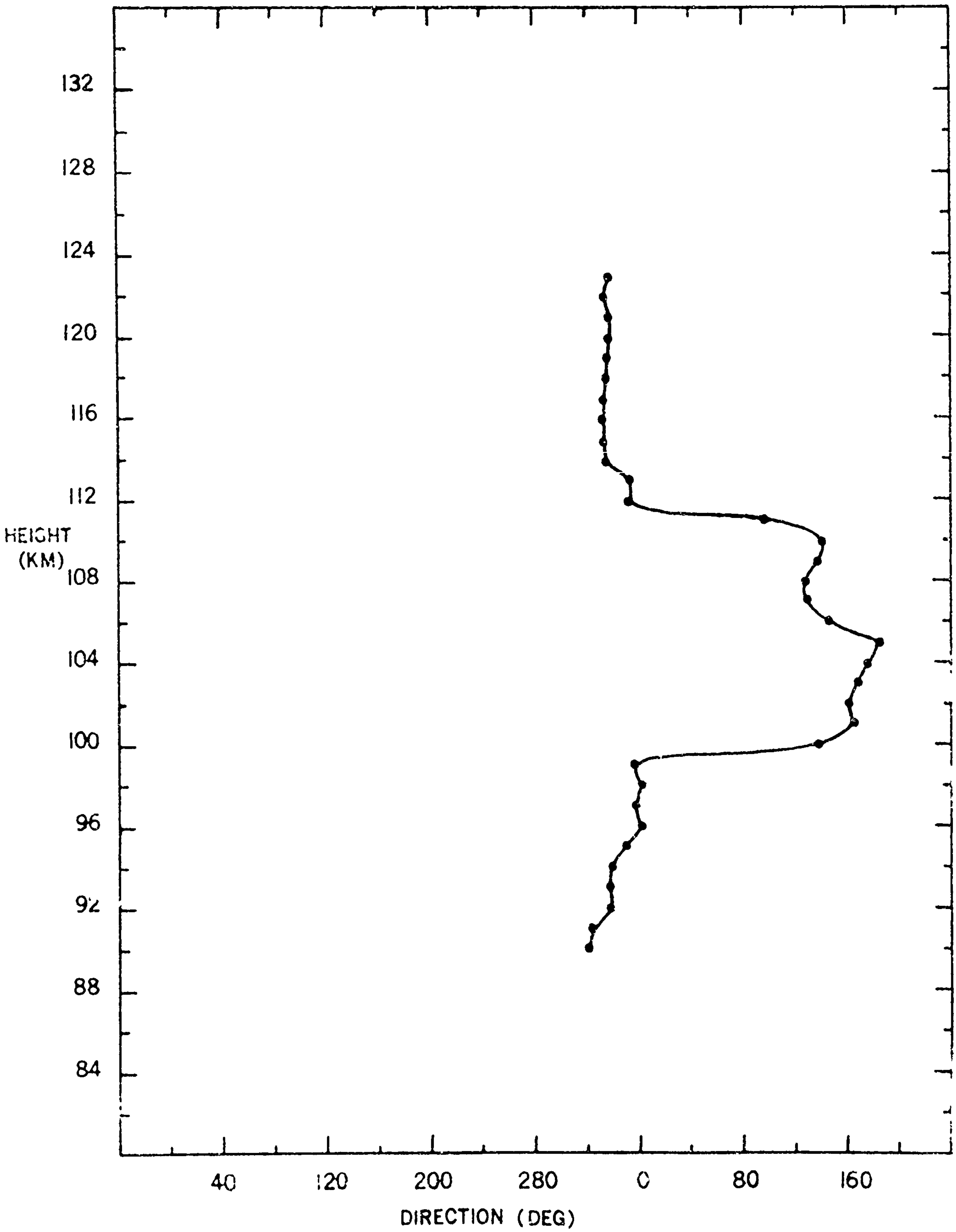
● UP TRAIL

▲ DOWN TRAIL

TRAIL NO. B48 PUERTO RICO

24 FEBRUARY 1966 03:27:00

H.A.R.P. BARBADOS



BARBADOS
UP TRAIL

TRAIL NO. B49 ST. THOMAS
24 FEBRUARY 1966

05-23-30 AST

| ALTITUDE (KM) | WIND HEADING (DEG) | WIND VELOCITY (M/S) | WIND COMPONENTS (M/S) GEOGRAPHIC N-S | GEOGRAPHIC E-W | MAGNETIC N-S | MAGNETIC E-W |
|---|---|---|---|---|---|---|
| 96.0 | 282.3 | 38.9 | 8.3 | -38.0 | 15.8 | -35.5 |
| 97.0 | 256.8 | 32.0 | -7.3 | -31.1 | -0.9 | -31.9 |
| 98.0 | 226.2 | 38.7 | -26.8 | -27.9 | -20.6 | -32.7 |
| 99.0 | 205.1 | 119.1 | -107.9 | -50.5 | -95.5 | -71.2 |
| 100.0 | 206.7 | 131.2 | -117.2 | -58.9 | -102.9 | -81.4 |
| 101.0 | 213.0 | 126.4 | -106.0 | -68.8 | -89.9 | -88.8 |
| 102.0 | 219.5 | 111.4 | -86.0 | -70.9 | -69.9 | -80.6 |
| 103.0 | 224.1 | 86.4 | -62.1 | -60.1 | -48.7 | -71.4 |
| 104.0 | 225.8 | 58.3 | -40.6 | -41.8 | -31.3 | -49.1 |
| 105.0 | 224.9 | 34.7 | -24.6 | -24.5 | -19.1 | -29.0 |
| 106.0 | 201.8 | 12.7 | -11.8 | -4.7 | -10.6 | -7.0 |
| 107.0 | 86.6 | 16.5 | 1.0 | 16.5 | -2.4 | 16.4 |
| 108.0 | 78.4 | 36.2 | 7.3 | 35.5 | 0.0 | 36.2 |
| 109.0 | 72.3 | 41.7 | 12.7 | 39.7 | 4.4 | 41.4 |
| 110.0 | 64.7 | 44.2 | 18.9 | 39.9 | 10.5 | 42.9 |
| 111.0 | 52.1 | 44.3 | 27.2 | 35.0 | 19.6 | 39.8 |
| 112.0 | 35.5 | 52.5 | 42.7 | 30.5 | 35.7 | 38.5 |
| 113.0 | 23.2 | 64.3 | 59.1 | 25.4 | 52.8 | 36.8 |
| 114.0 | 22.9 | 79.9 | 73.6 | 31.1 | 65.8 | 45.3 |
| 115.0 | 33.9 | 89.3 | 74.1 | 49.8 | 62.5 | 63.7 |
| 116.0 | 18.9 | 67.3 | 63.7 | 21.8 | 58.0 | 34.2 |
| 117.0 | 4.9 | 49.0 | 48.8 | 4.2 | 46.9 | 14.0 |

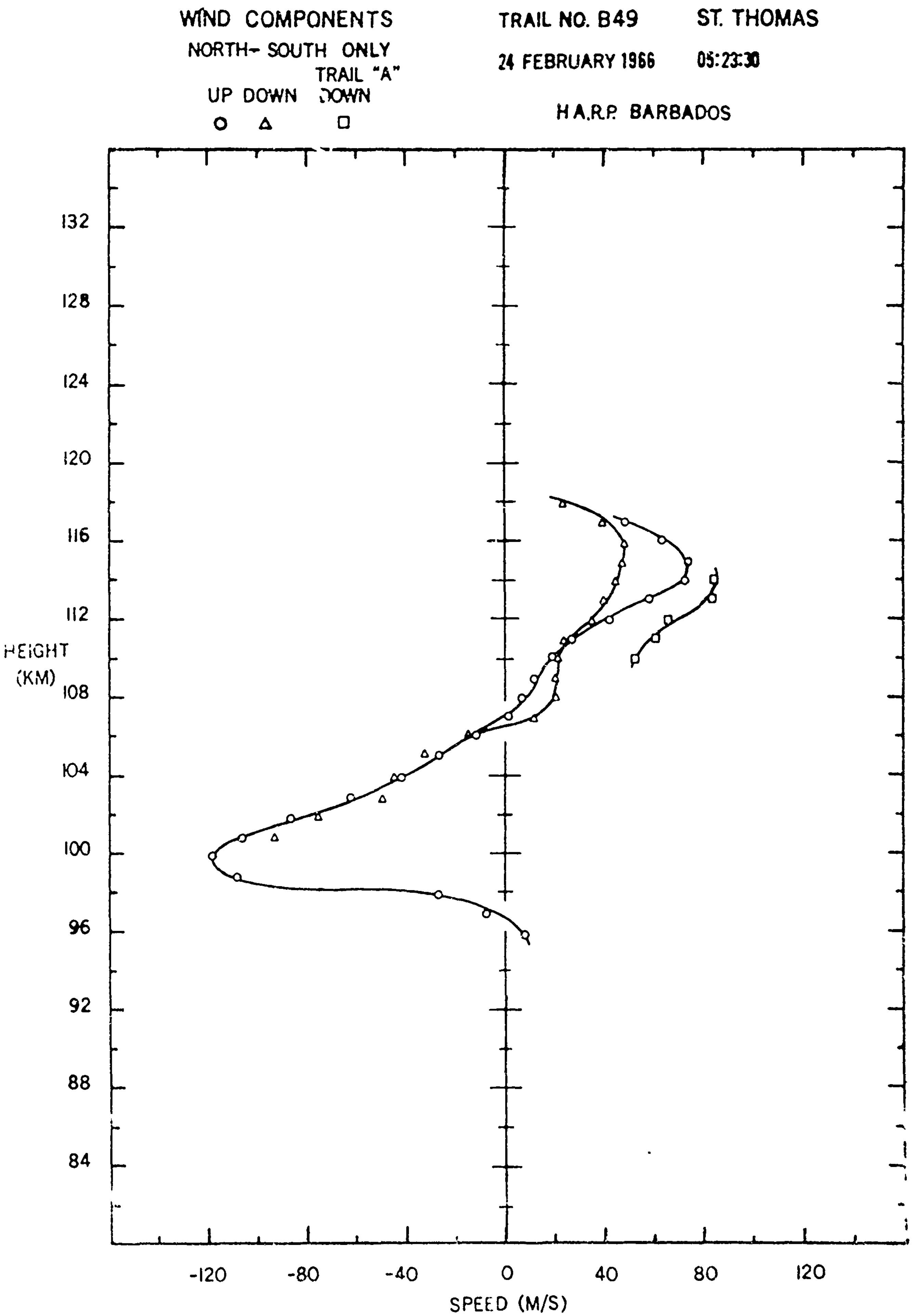
BARBADOS
DOWN TRAIL

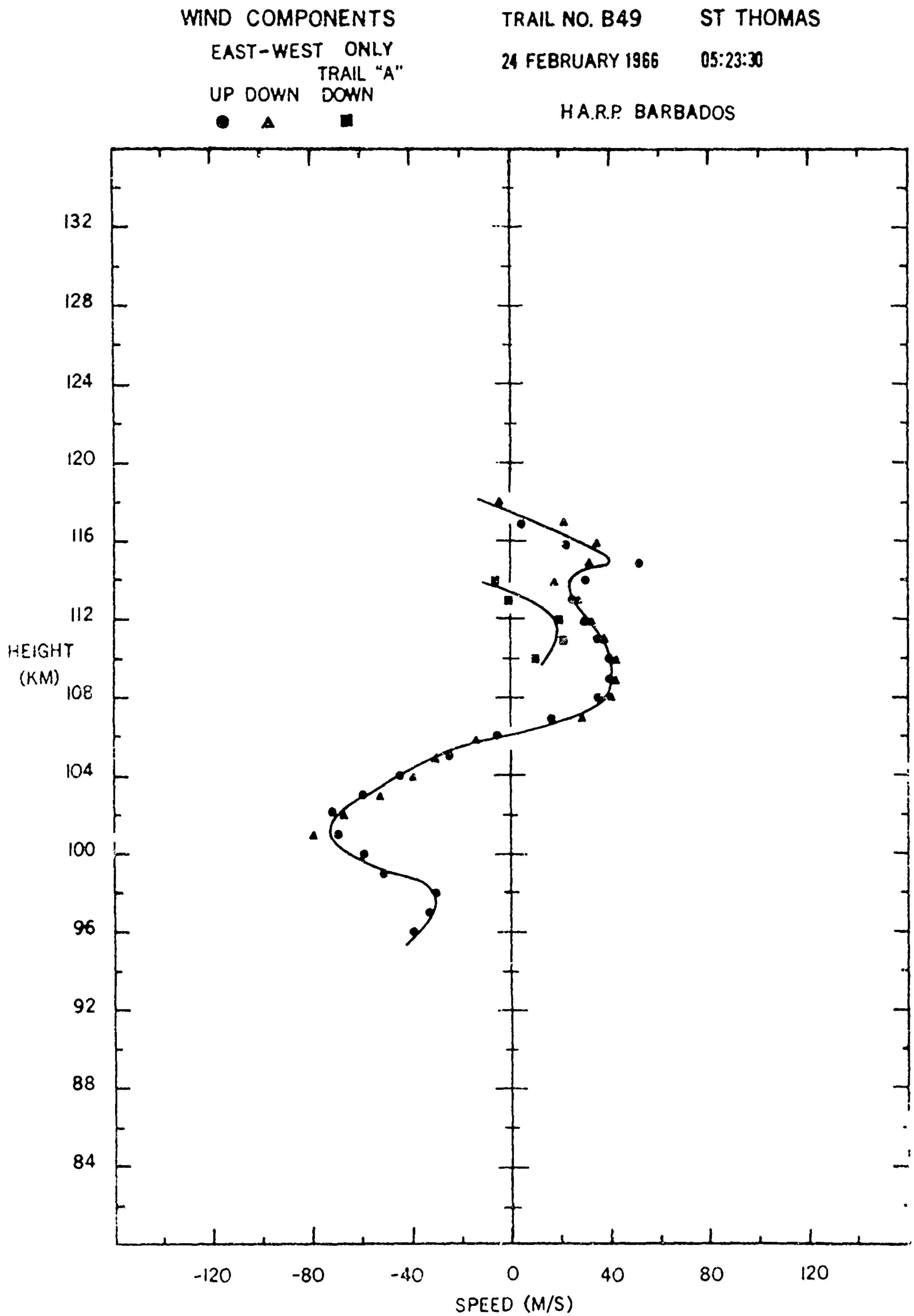
TRAIL NO. B49 ST. THOMAS
24 FEBRUARY 1966 · 05-23-30 AST

| ALTITUDE (KM) | WIND HEADING (DEG) | WIND VELOCITY (M/S) | WIND COMPONENTS (M/S) GEOGRAPHIC N-S | GEOGRAPHIC E-W | MAGNETIC N-S | MAGNETIC E-W |
|---|---|---|---|---|---|---|
| 101.0 | 220.2 | 121.7 | -93.0 | -78.5 | -75.2 | -95.7 |
| 102.0 | 222.8 | 99.2 | -72.8 | -67.4 | -57.7 | -80.7 |
| 103.0 | 226.1 | 70.5 | -48.9 | -50.8 | -37.6 | -59.6 |
| 104.0 | 224.3 | 56.8 | -40.7 | -39.7 | -31.8 | -47.1 |
| 105.0 | 224.6 | 43.4 | -30.9 | -30.5 | -24.1 | -36.1 |
| 106.0 | 223.8 | 19.5 | -14.0 | -13.5 | -11.0 | -16.0 |
| 107.0 | 66.5 | 32.5 | 13.0 | 29.8 | 6.7 | 31.8 |
| 108.0 | 62.4 | 46.6 | 21.6 | 41.3 | 12.8 | 44.8 |
| 109.0 | 64.2 | 46.4 | 20.2 | 41.8 | 11.3 | 45.0 |
| 110.0 | 62.1 | 47.8 | 22.3 | 42.2 | 13.3 | 45.8 |
| 111.0 | 55.9 | 43.1 | 24.1 | 35.7 | 16.4 | 39.8 |
| 112.0 | 43.9 | 48.4 | 34.9 | 33.5 | 27.4 | 39.9 |
| 113.0 | 32.8 | 47.1 | 39.6 | 25.5 | 33.6 | 33.0 |
| 114.0 | 20.3 | 47.9 | 44.9 | 16.6 | 40.6 | 25.3 |
| 115.0 | 33.8 | 57.2 | 47.5 | 31.8 | 40.1 | 40.7 |
| 116.0 | 34.9 | 59.9 | 49.1 | 34.3 | 41.2 | 43.5 |
| 117.0 | 26.6 | 46.4 | 41.5 | 20.7 | 36.5 | 28.7 |
| 118.0 | 347.1 | 24.6 | 24.0 | -5.5 | 24.6 | -0.5 |

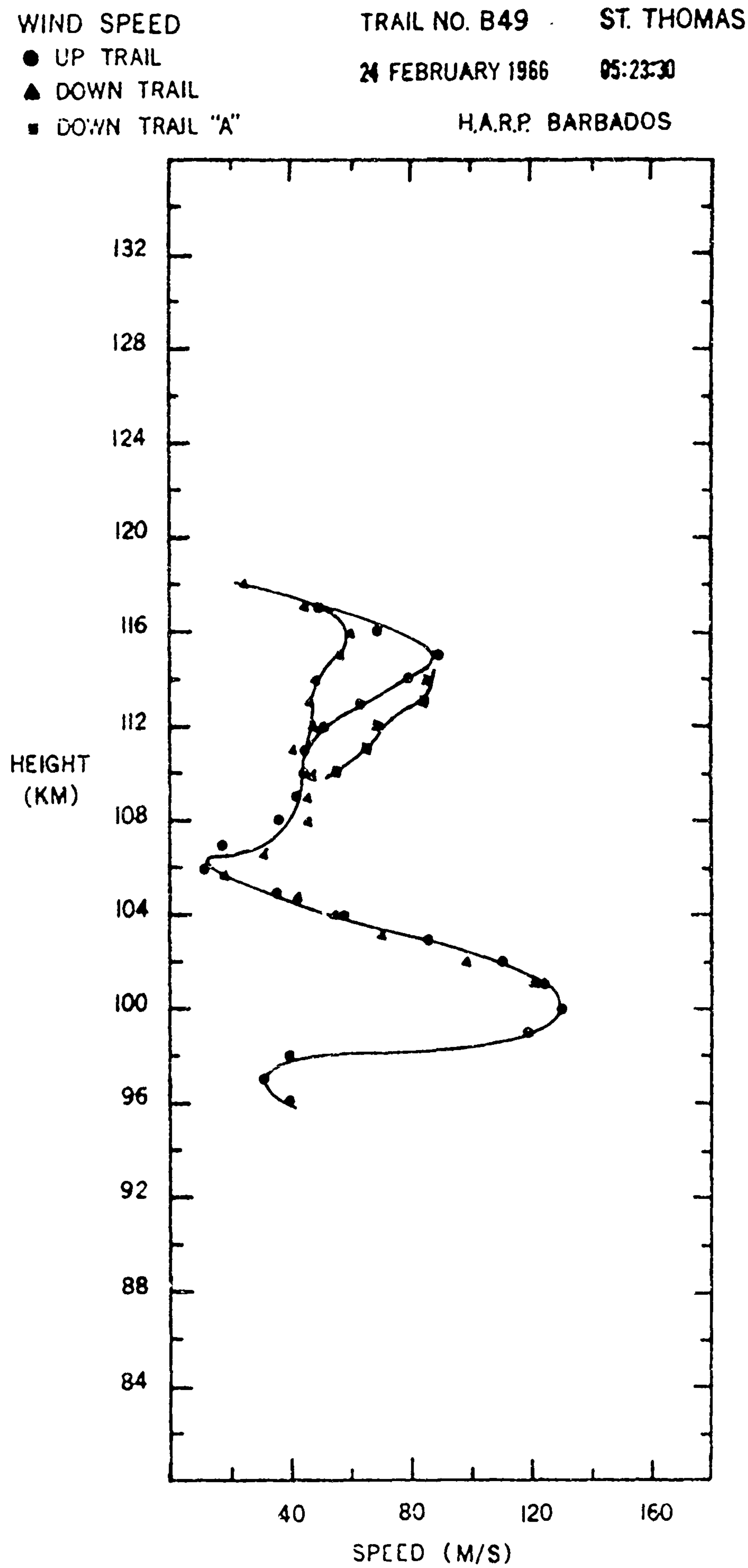
TRAIL A
DOWN TRAIL

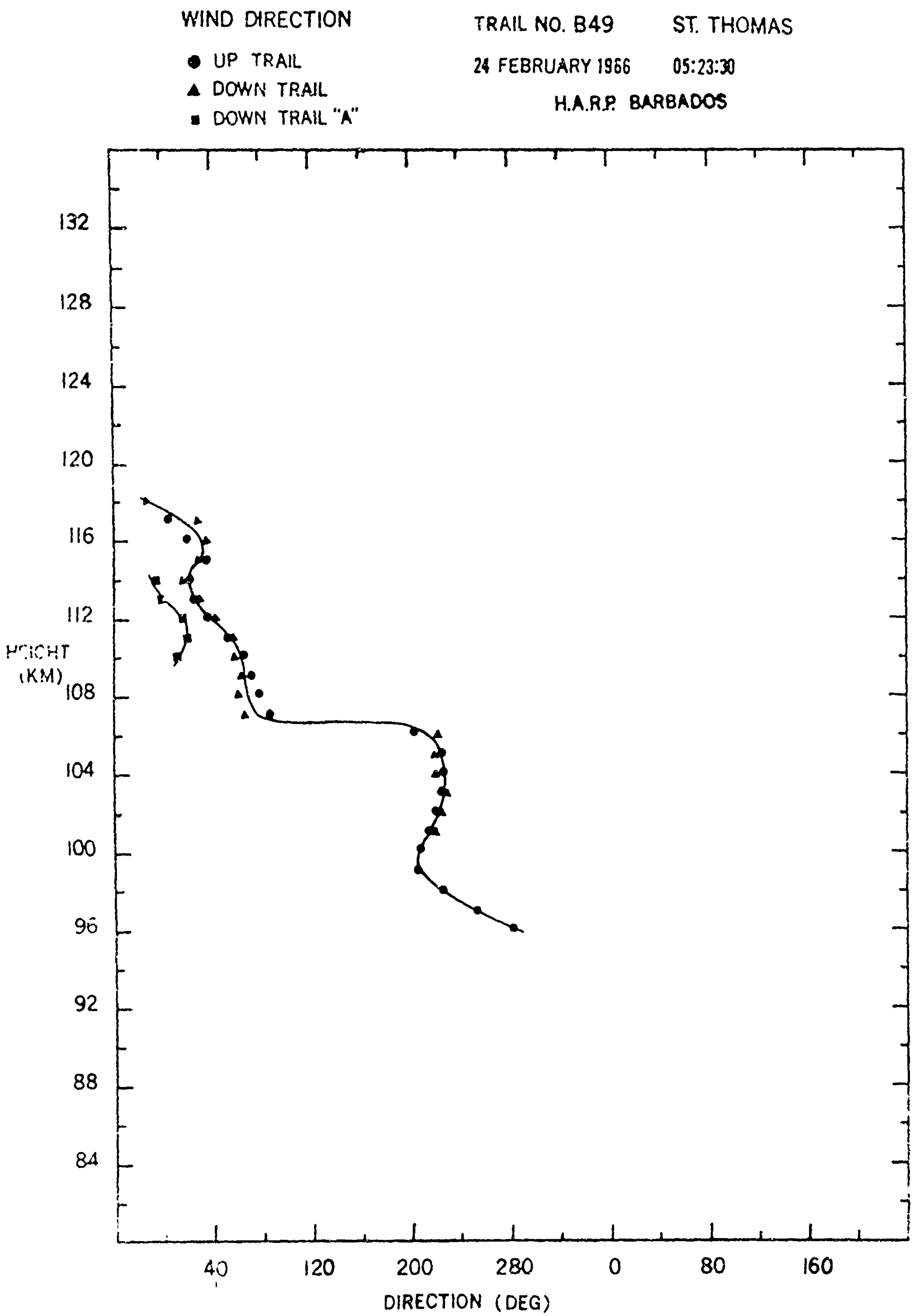
| ALTITUDE (KM) | WIND HEADING (DEG) | WIND VELOCITY (M/S) | WIND COMPONENTS (M/S) GEOGRAPHIC N-S | GEOGRAPHIC E-W | MAGNETIC N-S | MAGNETIC E-W |
|---|---|---|---|---|---|---|
| 110.0 | 10.9 | 54.4 | 53.4 | 10.2 | 50.2 | 20.8 |
| 111.0 | 19.9 | 65.4 | 61.5 | 22.3 | 55.7 | 34.3 |
| 112.0 | 16.4 | 68.4 | 65.6 | 19.3 | 60.4 | 32.1 |
| 113.0 | 359.3 | 85.0 | 85.0 | -1.0 | 83.5 | 16.2 |
| 114.0 | 355.2 | 85.[illegible] | 85.3 | -7.2 | [illegible].0 | 10.2 |


WIND COMPONENTS
NORTH- SOUTH ONLY
TRAIL "A"
UP DOWN DOWN
TRAIL NO. B49
ST. THOMAS
24 FEBRUARY 1966
05:23:30
H.A.R.P. BARBADOS
HEIGHT (KM)
132
128
124
120
116
112
108
104
100
96
92
88
84
-120
-80
-40
0
40
80
120
SPEED (M/S)



WIND COMPONENTS
EAST-WEST ONLY
TRAIL "A"
UP DOWN DOWN
TRAIL NO. B49
ST THOMAS
24 FEBRUARY 1966
05:23:30
H.A.R.P. BARBADOS
HEIGHT (KM)
132
128
124
120
116
112
108
104
100
96
92
88
84
-120
-80
-40
0
40
80
120
SPEED (M/S)

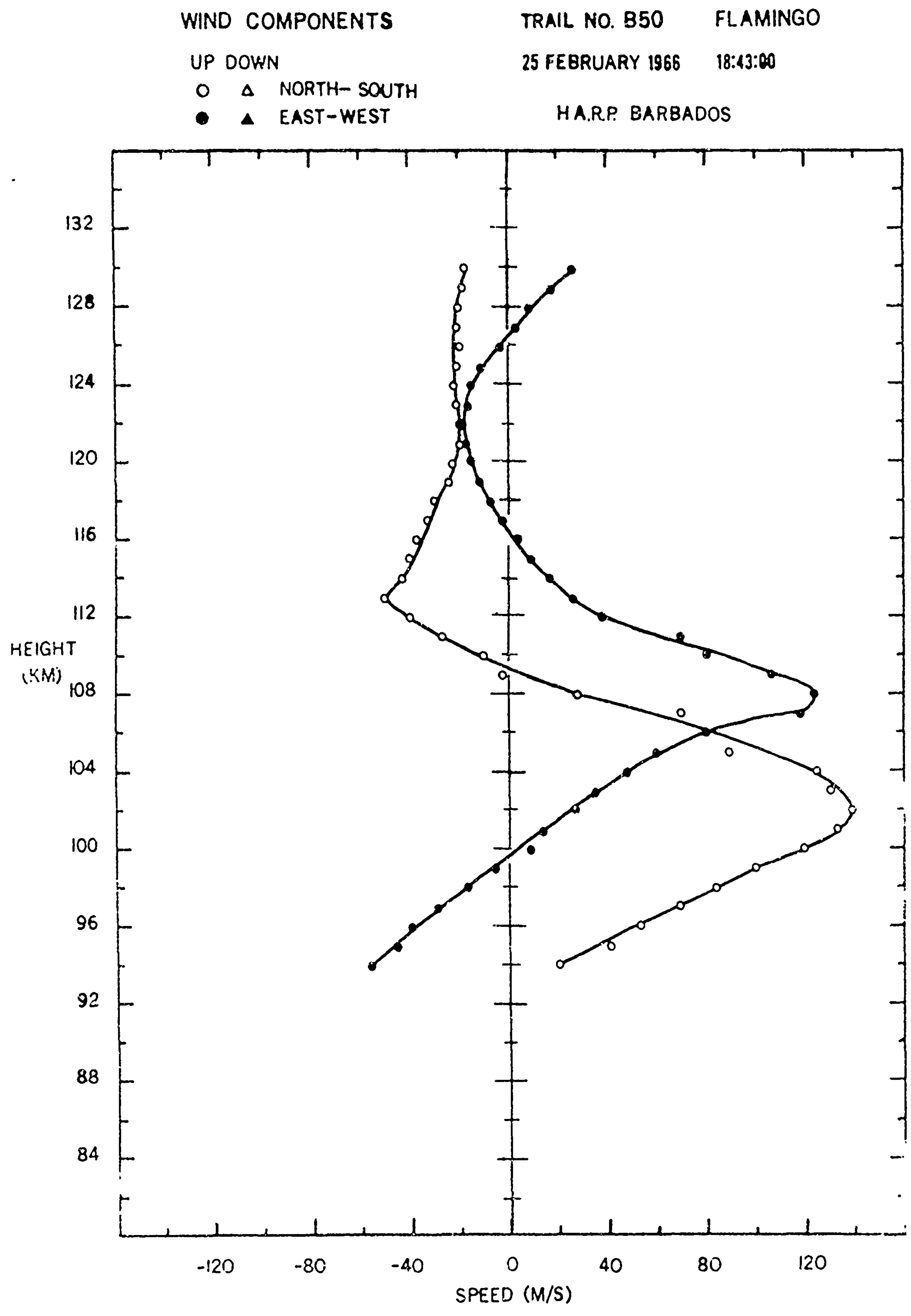

WIND SPEED
UP TRAIL
DOWN TRAIL
DOWN TRAIL "A"
TRAIL NO. B49
ST. THOMAS
24 FEBRUARY 1966
05:23:30
H.A.R.P. BARBADOS
HEIGHT (KM)
132
128
124
120
116
112
108
104
100
96
92
88
84
40
80
120
160
SPEED (M/S)


WIND DIRECTION
UP TRAIL
DOWN TRAIL
DOWN TRAIL "A"
TRAIL NO. B49
ST. THOMAS
24 FEBRUARY 1966
05:23:30
H.A.R.P. BARBADOS
HEIGHT (KM)
132
128
124
120
116
112
108
104
100
96
92
88
84
40
120
200
280
0
80
160
DIRECTION (DEG)

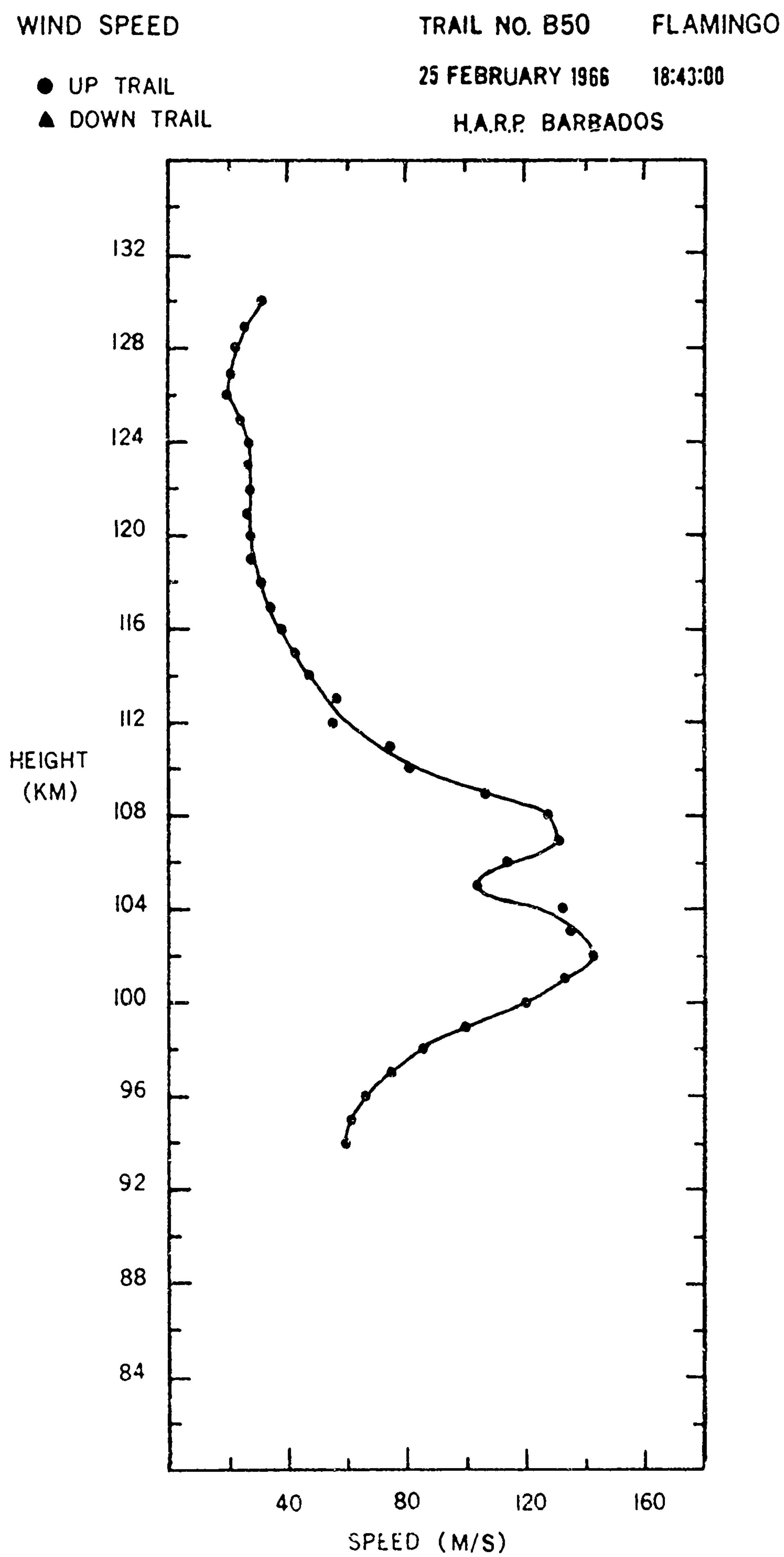
TRAIL NO. B50 FLAMINGO

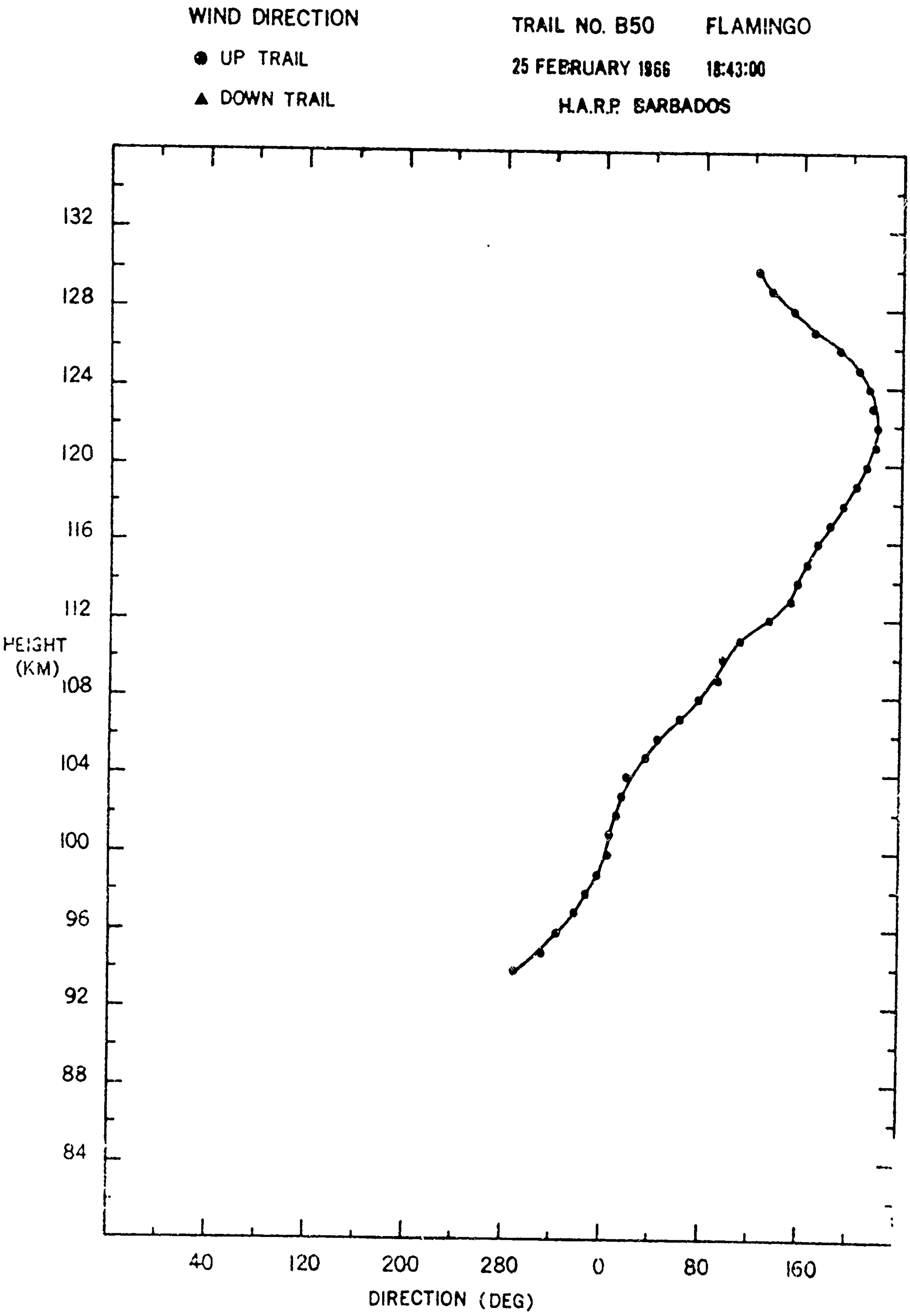
BARBADOS — 25 FEBRUARY 1966 — 18-43-00 AST

| ALTITUDE (KM) | WIND HEADING (DEG) | WIND VELOCITY (M/S) | WIND COMPONENTS (M/S) GEOGRAPHIC N-S | GEOGRAPHIC E-W | MAGNETIC N-S | MAGNETIC E-W |
|---|---|---|---|---|---|---|
| 94.0 | 289.6 | 59.6 | 20.0 | -56.2 | [illegible] | [illegible] |
| 95.0 | 312.0 | 61.4 | 41.1 | -45.6 | 49.5 | [illegible] |
| 96.0 | 323.1 | 65.8 | 52.6 | -39.5 | [illegible] | -28.1 |
| 97.0 | 337.6 | 74.7 | 69.1 | -28.4 | [illegible] | -13.9 |
| 98.0 | 348.7 | 85.1 | 83.5 | -16.7 | [illegible] | [illegible] |
| 99.0 | 356.9 | 99.8 | 99.6 | -5.3 | 98.6 | [illegible] |
| 100.0 | 3.8 | 119.4 | 119.1 | 8.0 | 115.0 | 31.9 |
| 101.0 | 5.8 | 133.3 | 132.6 | 13.6 | 127.1 | 40.1 |
| 102.0 | 11.3 | 141.9 | 139.2 | 27.7 | 130.7 | [illegible] |
| 103.0 | 15.5 | 135.2 | 130.3 | 36.1 | 120.3 | 61.7 |
| 104.0 | 20.5 | 133.6 | 125.1 | 47.0 | 113.0 | 71.3 |
| 105.0 | 34.9 | 103.2 | 84.7 | 59.1 | 71.0 | 75.0 |
| 106.0 | 44.5 | 114.7 | 81.9 | 80.3 | 64.0 | 95.2 |
| 107.0 | 63.0 | 132.7 | 60.3 | 118.2 | 35.2 | 127.9 |
| 108.0 | 77.0 | 126.8 | 28.5 | 123.6 | 3.0 | 126.8 |
| 109.0 | 92.0 | 106.7 | -3.8 | 106.6 | -25.2 | [illegible] |
| 110.0 | 97.4 | 80.7 | -10.4 | 80.0 | -26.3 | 75.3 |
| 111.0 | 111.1 | 74.7 | -27.0 | 69.7 | -40.5 | [illegible] |
| 112.0 | 136.9 | 54.9 | -40.1 | 37.6 | -46.9 | 28.7 |
| 113.0 | 153.2 | 56.1 | -50.0 | 25.3 | -54.1 | 14.7 |
| 114.0 | 159.4 | 47.2 | -44.2 | 16.6 | -46.6 | 7.3 |
| 115.0 | 166.5 | 41.9 | -40.7 | 9.8 | -41.8 | 1.4 |
| 116.0 | 173.4 | 37.3 | -37.1 | 4.3 | -37.2 | -3.3 |
| 117.0 | 183.8 | 34.0 | -33.9 | -2.2 | -32.8 | -9.0 |
| 118.0 | 193.5 | 30.7 | -29.9 | -7.2 | -27.8 | -13.1 |
| 119.0 | 204.5 | 26.7 | -24.3 | -11.1 | -21.6 | -15.8 |
| 120.0 | 212.0 | 27.3 | -23.1 | -14.5 | -19.7 | -18.9 |
| 121.0 | 220.6 | 26.0 | -19.7 | -16.9 | -15.9 | [illegible] |
| 122.0 | 221.7 | 27.1 | -20.3 | -18.0 | -16.2 | [illegible] |
| 123.0 | 216.5 | 26.6 | -21.4 | -15.8 | -17.8 | [illegible] |
| 124.0 | 214.1 | 26.9 | -22.3 | -15.1 | -18.8 | -19.3 |
| 125.0 | 207.5 | 24.0 | -21.3 | -11.1 | -18.6 | -15.2 |
| 126.0 | 190.9 | 19.9 | -19.6 | -3.8 | -18.4 | -7.7 |
| 127.0 | 170.2 | 20.4 | -20.1 | 3.5 | -20.4 | -0.6 |
| 128.0 | 154.5 | 22.0 | -19.9 | 9.5 | -21.4 | 5.3 |
| 129.0 | 135.5 | 25.5 | -18.2 | 17.8 | -21.4 | 13.8 |
| 130.0 | 123.7 | 31.5 | -17.5 | 26.2 | -22.4 | 22.1 |



WIND COMPONENTS
TRAIL NO. B50
FLAMINGO
UP DOWN
25 FEBRUARY 1966
18:43:00
O Δ NORTH- SOUTH
● ▲ EAST-WEST
H.A.R.P. BARBADOS
132
128
124
120
116
112
HEIGHT (KM)
108
104
100
96
92
88
84
-120
-80
-40
0
40
80
120
SPEED (M/S)


WIND SPEED
TRAIL NO. B50
FLAMINGO
● UP TRAIL
▲ DOWN TRAIL
25 FEBRUARY 1966
18:43:00
H.A.R.P. BARBADOS
HEIGHT (KM)
132
128
124
120
116
112
108
104
100
96
92
88
84
40
80
120
160
SPEED (M/S)



WIND DIRECTION
UP TRAIL
DOWN TRAIL
TRAIL NO. B50
FLAMINGO
25 FEBRUARY 1966
18:43:00
H.A.R.P. BARBADOS
HEIGHT (KM)
132
128
124
120
116
112
108
104
100
96
92
88
84
40
120
200
280
0
80
160
DIRECTION (DEG)

UNCLASSIFIED

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Robert L. Fuller

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13. ABSTRACT


On the night of 23-24 February 1966, six luminous trails were produced between 87km and 131km by the release of tri-methyl-aluminum from projectiles fired from a smoothbore sixteen-inch gun located on the West Indian island of Barbados (57.5°W, 13.1°N). Single trails were also produced on the nights of 17 February 1966 and 25 February 1966. These trails were photographed from neighboring islands and analyzed to yield wind profiles. This report contains the tabulated wind data for all eight trails together with plots versus altitude of wind components, wind speed, and wind heading.


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| | ROLE | WT | ROLE | WT | ROLE | WT |
| HARP<br>High Altitude Research Project<br>Ionospheric Winds | | | | | | |